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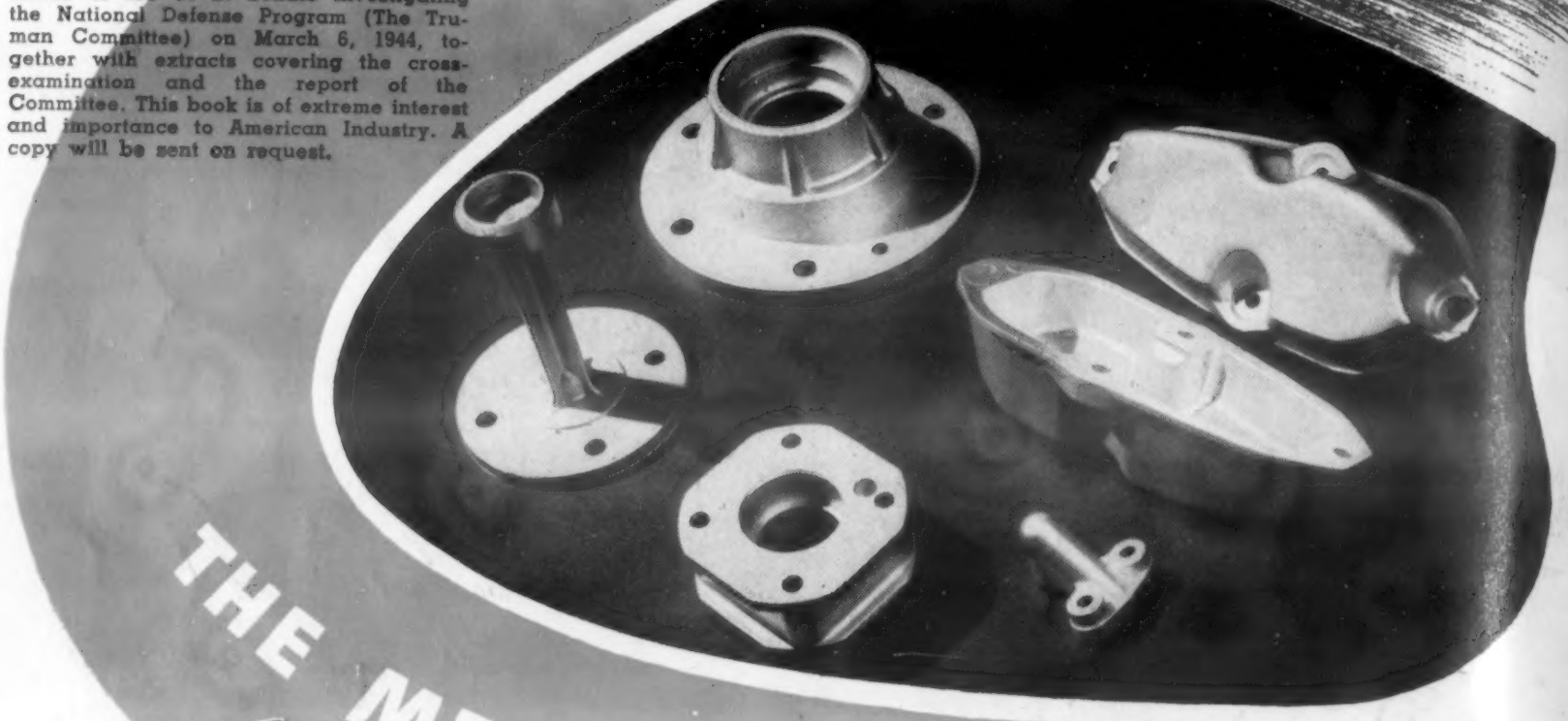
METALS and ALLOYS

The engineering magazine of the Metal Industries

Metal Production · Metal Working · Materials and Design

DOWMETAL *magnesium products*



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METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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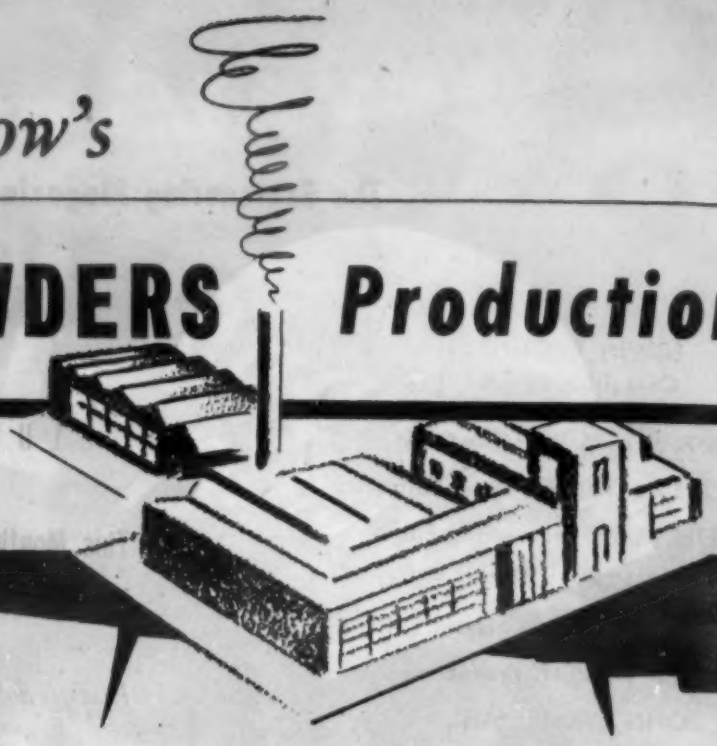

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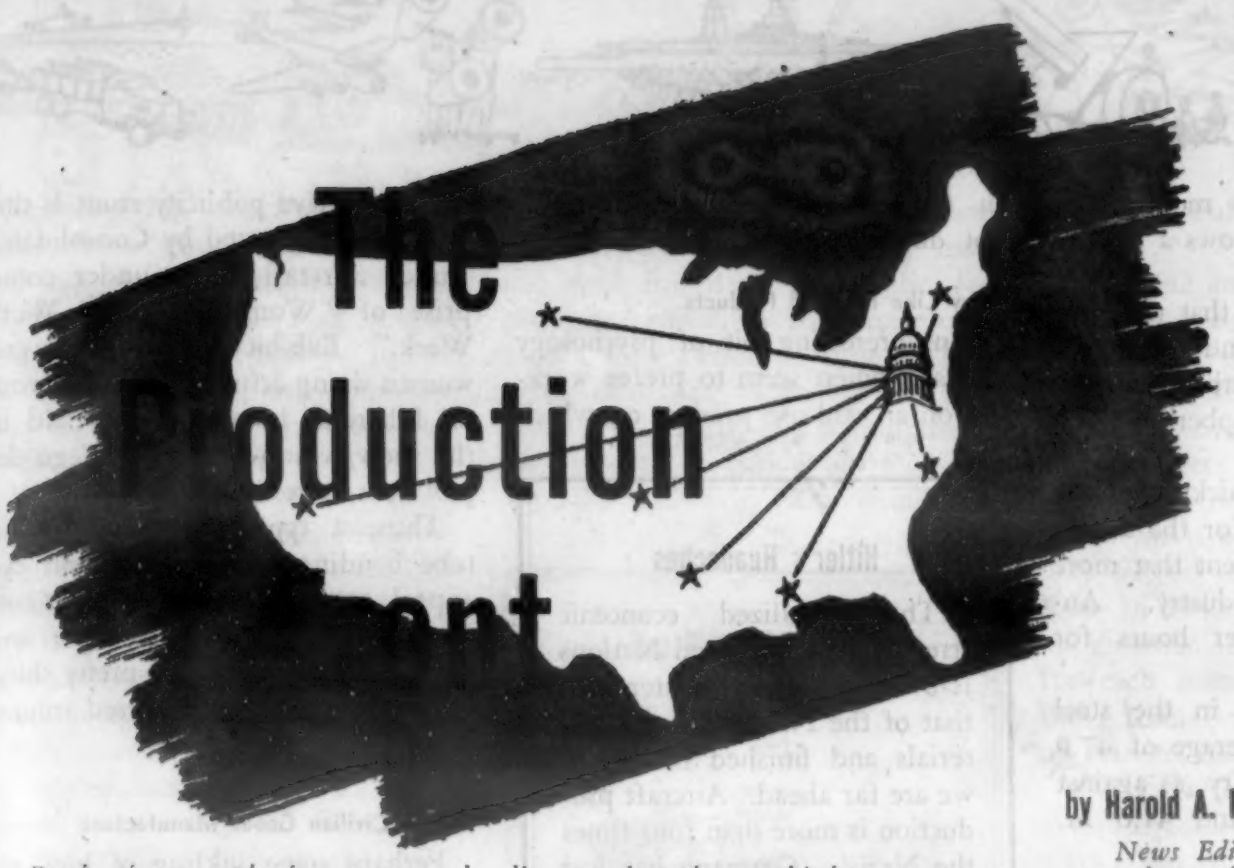


Production emphasis now on landing craft, planes, high octane gas, synthetic rubber and communications. . . . Bombers best production spot. . . . Copper tight for duration. . . . Aluminum scrap not highly critical. . . . Situation in components better.

Soldier draft means more women and longer work hours in industry. . . . New steel plant hires 48% women . . . 2,000,000 more needed. . . . They prefer to work on things their sweethearts use directly. . . . Electric alarm clocks may set pattern for civilian goods.

Great Lakes iron ore sailors used to "get religion." . . . Zinc industry down-to-earth post-war ideas. . . . They estimate in tons the "pent-up" markets. . . . Proposed hardenability bands. . . . Hitler loses manganese, chromium, etc. . . . We saw some novelties in a new wire mill, such as khaki-colored razor blades. . . . Glamour is mechanized.

Men—Not Materials—Are Scarce

by Harold A. Knight

News Editor

Empasis on war production now is on landing craft, planes, high octane gas, synthetic rubber and communications items, it was stated recently by William L. Batt, vice chairman, War Production Board. Productive capacity of the United States has increased 20% in man-hours over 1943.

The chief problem now is maintaining a supply line in keeping with the attrition rate. Production of heavy bombers is rising rapidly, and is the brightest spot in the output picture. There is no limitation of output, because of lack of materials, concluded Mr. Batt.

Among basic materials, copper still remains the metal that most borders on criticalness. "Copper will be tight for the duration of the war," stated WPB officials recently, who also said that demands on the mills for brass wire are greater than they have ever been.

Orders for steel rod and wire should be placed with mills as far ahead as possible, they said. Alloy steel has been generally available but carbon steel is still scarce. Industry was urged to use triple alloy steel where possible.

The head of the Aluminum and Magnesium Div., WPB, stated recently that aluminum scrap is not highly critical, but that its conservation for essential uses remains desirable.

During 1943 smelters reprocessed into ingots 400 million lb. of aluminum scrap, and about two months' supply of scrap is on hand. Such scrap should be carefully segregated, since most alloying metals, with the exception of magnesium and calcium, cannot be removed from aluminum.

Components Are More Abundant

Proceeding along the line to components, the tight situation on ball bearings has eased, with deliveries now abreast of requirements. Components for test instruments are still very critical, holding up production of these instruments by 30 to 50%. Moreover, requirements for 1944 will exceed those of 1943 by 60%.

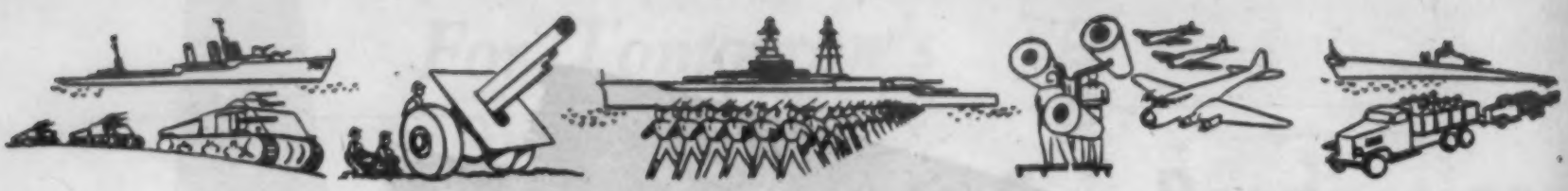
The situation with regard to aluminum alloy extrusions for aircraft is much better, both because of new production facilities and some conversions to rolled sections. Shipments of aluminum castings and aluminum fabricated products reached new peaks in January.

Monthly unit shipments of resistors for military electronic equipment are 50% higher than a year ago, and the industry will probably meet all military requirements for 1944.

Production of foundry molding machines, on which there is a backlog of unfilled orders equal to up to eight months production, is being increased, aided by more sub-contracting. Supplies of steel blast grit for finishing surfaces have been stepped up recently.

Need for Women More Urgent

The problem of labor supply continues much more severe than that of materials. Labor is perhaps not



as hoity-toity as a few months ago. Trend in quit rates shows a marked drop.

The basic reason is that the drop in total new hirings and the layoffs that have resulted in cutbacks on war contracts have had a sobering effect on labor.

With almost a panicky demand for more young men for the armed forces, it becomes evident that more women must enter industry. Another answer is longer hours for those who work.

Thus, wage earners in the steel industry worked an average of 47.0 hr. per week in February, as against 45.7 hr. in January and 41.6 hr. in February, 1943.

Women are 48% in Steel Plant

As to womanpower, one of the most striking examples is that of the new Gary plant of the Tubular Alloy Steel Corp., U. S. Steel subsidiary, which opened April 5. Being a new mill, it naturally started out reflecting latest labor conditions.

Of the 3,700-odd employees, 48% are women, despite the fact that this is classed as heavy industry. Women serve as crane operators, hookers, testers, draw bench and machine operators, tractor operators, truck drivers, chauffeurs, etc.

Women now hold one out of three jobs in the United States, but the number must be increased by nearly 2,000,000 by mid-year. Most of the increase will be in seasonal employment, such as canning and agriculture.

Radar and other electrical industries will provide the greatest number of new jobs for women. One Radar plant would employ females up to 90% of its force.

The turnover rate among women has reached alarming proportions in some areas. Many laid-off because of cut-backs do not try for new employment. Fatigue, lack of community services and difficulties in doing home supervision at the same time as plant work are the chief reasons for quitting.

Between January and February there was a drop of 200,000 women in the labor force, and this was not due to seasonal influences.

They Like Finished Products

An interesting bit of psychology is that women seem to prefer working on an end-use product on which no further manufacturing is needed — such as a bomber or a tank, for then they feel closer partnership with a sweetheart, husband or brother who, by some chance, might be using the very piece of equipment she helped make.

Hitler's Headaches

The mobilized economic strength of the United Nations is overwhelmingly greater than that of the Nazis. In raw materials and finished munitions we are far ahead. Aircraft production is more than four times the Nazis'. Germany has lost Nikopol, her chief source of manganese. Turkey has agreed to cut off shipments of chrome, which had supplied half of Germany's needs. At any time, we may cut the rail and barge lines and shut off these supplies completely.

More pressure is being placed on Sweden to cease shipping iron ore to Germany, and we are destroying increasing quantities by bombing ore barges and freight trains. At least one-third of Germany's oil came from Ploesti in Rumania, which may have been captured by the time this comes out in print.

In German electric motors of recent manufacture zinc alloy replaces copper — they quickly burn out. Only mere slivers of tips on cutting tools are of tungsten. Women in war plants are given to gossiping, and often 40% of the precision work has to be scrapped. Food from the Ukraine is still another story!

An effective publicity stunt is that recently inaugurated by Consolidated Vultee Aircraft Corp. under enterprise of "Women in War Work Week." Exhibits featuring Convair women doing actual production work on Liberator bombers were held in the show windows of San Diego department stores.

Thus, a typical display was on tube bending. A woman with eye appeal, snappily dressed in plant costume, adjusted a die or shaper and performed wizardry with pretty shiny tubes. Large crowds gathered around the store window.

Tip on Civilian Goods Manufacture

Perhaps some inkling of how return to manufacture of civilian goods will be handled is afforded by the electric "War Alarm" clock being manufactured at Bridgeport, Conn. by General Electric Co., and scheduled to be sold to the general public May 1.

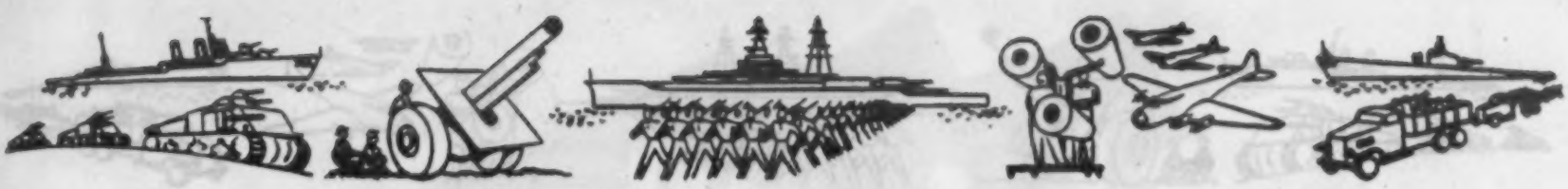
The design is different from any used in pre-war. It carries a regular standard guarantee, and is not of inferior quality. Except for minor non-operating parts, materials are the same as in pre-war model clocks.

WPB has established quotas for each geographical area, based on the distribution of electric clock sales in 1941. The maximum retail price is set at $4.95 each.

Anecdote of the Iron Ore Sailors

If shipments of iron ore fall down in the 1944 season from set goals of over 90,000,000 tons, it will be because of the draft and lack of manpower to run the ships, it was stated recently by WPB. There is plenty of shipping space available, however. This reminds us of a historical anecdote told us by an old-time native of Cleveland.

Probably more iron ore executives live in Shaker Heights, Ohio, a fashionable suburb of Cleveland, than in any other community in the world. It received its name from the original Shakers, a religious sect, who settled about seven miles from the heart of Cleveland. They always greeted profusely converts to their religion.



Realizing this, sailors on the Great Lakes, those who helped haul ore, coal and wheat, invariably when the shipping season was over around Dec. 1 betook themselves to the Shaker Community and expressed their eagerness to become converted to the Shaker religion.

Now, the Shakers were primarily farmers. Farm life from Dec. 1 to April 15 is not onerous. So the converted sailors settled down to the easy farm life of the winter, eating well and kept snug in the dreary winter climate around those parts.

But — come April 15, when the ice melted from the Lakes — the sailors threw overboard their religion and drifted back to the lakes. Come next Dec. 1, and they became re-converted to the Shaker religion. And, according to the story, the Shakers were very lenient people.

Old-Time Products vs. Newcomers

There are two important lines of thought that most industrialists dwell upon in their more meditative moments: First, will a basic product, used for many centuries, hold its own with the new materials? Second, what, in actual figures, will be the post-war demand for our product?

Reams have been written on post-war plans. But, alas, there are by far too many generalities, trite statements and eyewash. It is refreshing, therefore, to run across a treatise that answers well the two questions in the first paragraph.

This is the address on "Post-War Outlook for Galvanizing," by Nelson E. Cook, Wheeling Steel Corp., before the American Zinc Institute on April 18. Moreover, zinc, the "Cinderella" metal, is a typical old-established, non-glamorous commodity, and a perfect guinea pig for the questions under consideration.

"Probably no industry has been so completely overturned during the war period," states Mr. Cook. "It has almost lost its normal markets in favor of war markets. Quality of products has been dictated by Government restrictions. This situation is an ideal one for the development of substitutes.

"Galvanized products always have had inherent merits, and they have not been forced on the public, for products cannot be so forced over such a long period of time. These being confusing times, we are confronted with many new developments and substitutes, backed up with advertising and 'fairy-tale' claims.

Too Much Contrast

by V. M. McConnell

Brown is on the battlefront
Fighting for his life;
Black is making money
With his uncle and his wife.

Brown is in the Army
And daren't miss a day;
Black is in a war plant
And often slips away.

Brown gets sweat and sorrow—
Black gets sleek and slack.
The fellow Brown's a hero
But damn that fellow Black!

"Since we are all gullible, we might accept these at their face value. To one who is the fourth generation of a family of galvanizers who have been in the business since the early 1800's in England and the U. S., it seems rather ridiculous that such thoughts would be seriously entertained.

"In 1942 and 1943 we have accumulated unsatisfied demands, and we will build up more in 1944 and each year until victory. About 52% of our zinc consumption goes into galvanized sheets in normal times.

In 1939, the output of zinc-coated sheets was 1,600,000 tons; in 1942, only 69,000 tons and in 1943, still less. In 1942 the industry therefore underconsumed 78,000 tons and so for each subsequent year. Hence, these tonnages represent the pent-up markets for post-war.

"When a consumer is deprived of a useful commodity that he has always taken for granted, he suddenly becomes shocked and alarmed. He thinks about it and, in thinking about it, he has come to a realization of its value."

Proposed Hardenability Bands

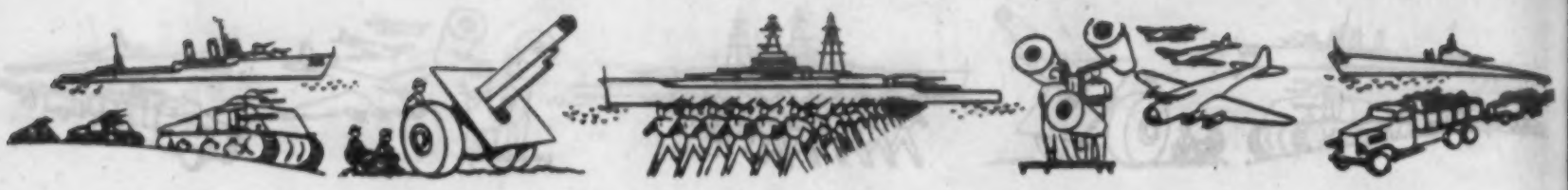
Looking toward the use of hardenability curves instead of chemical specifications by designers of steel parts and structures, a joint effort of the American Iron & Steel Institute and the Society of Automotive Engineers is being accelerated. Also, to fill the gap in hardenability between NE 8740 and 4340, it is planned to develop a modified chromium-nickel-molybdenum steel.

The work on hardenability curves is being focused on the more popular specifications, and as a result of a recent conference of the AISI Alloy Steel Technical Committee and an SAE Group, the project was shifted into high gear.

By the late Spring, tentative hardenability bands or limits for all popular grades of steel will have been formulated, and will be distributed by the SAE for user reaction. Modified chemistry will apply to steel purchased to these bands.

It is planned to publish them subsequently as a joint AISI-SAE project. These bands will be subject to later review at some definite date, such as six months after their original issue.

To illustrate the procedure that the AISI proposes to follow in de-



veloping the bands for user review through the SAE, a band for NE 8740 was used as an example. The committee stated that if higher low limits or lower high limits are required than provided by the tentative bands, necessary changes in chemistry would have to be made. The procedure used in developing the tentative bands will be published by the AISI.

The AISI group recommended that, if the bands formulated are satisfactory, specific points only be used as limits for specification purposes, and that otherwise two point Rockwell C plus or minus should apply. No band limits are to be shown below Rockwell C.

It was further recommended that producers report on shipping papers the hardenability of the heat in the same manner as composition, the hardenability data to consist of points or complete results as required.

Steels purchased to the bands are to be identified by the suffix letter "H" following the identification number, and when such reference appears, modified chemical composition will apply.

Tests will be made on cast specimens that have been found to give representative results. Testing procedure will be in accordance with the SAE standard, except for quenching and normalizing temperatures.

To reduce the differences in results obtained in different laboratories, the SAE was asked to review its test standard with a view to making it more precise, and a subdivision of the SAE Iron & Steel Division is being organized for this purpose.

Producers and consumers have been asked to file test data on all heats furnished to hardenability requirements for use in making revisions in the bands.

Representing the SAE at the conference were the iron and steel committee of the War Engineering Board, user members of the executive committee of the Iron & Steel Div., SAE Standards Committee, and representatives of the materials and processes subdivision, SAE Aeronautic Div.

So That's Where Bad Wire Comes From!

We spent nearly a full day in the new South Works steel wire mill of the American Steel & Wire Co. at Worcester, Mass.

We were impressed by the storage rack, made of fabricated steel, where incoming wire rods are stored until called for, so ingenious it is being copied by others; by the inside motor trucks that replace the conventional wire mill "buggy"; by a hardening furnace that is permanently tilted so that razor blade steel passes through by gravity and is not marred; by the many hand-operated individual lifts to save muscles; by certain strip steel rolled as thin as this paper and so fragile that it tore like paper; by the beauty of steel wires coated with copper, tin or cadmium, or combinations of these; by straw-colored razor blades for soldiers to match their khaki.

We were interested to learn that virtually all razor blades throughout the world are by now made of open hearth steel (we had thought many were made from electric or crucible steel); that razor blades are better than ever before — at least more uniform in quality; that Bessemer steel makes the best steel wool.

We asked why strips, which are made on rolling mills, should be manufactured by a wire company. It all started many years ago when a certain customer asked to have his wire made flat.

It was interesting to learn what an important innovation tungsten carbide wire drawing dies proved ten years ago. Now only the very fine wires are drawn through diamonds. Production of one kind of wire is as fast as 1800 ft. per min. per machine. An output of 1400 ft. is common.

It is a dull day indeed when some chuckle is not forthcoming. "Here is the simplest way to test wire," a department superintendent explained to us. He bent it back and forth a couple of times, gave it a loop and then a sharp pull. "There, see that split? That is bad wire."

"But," we asked in seeming astonishment, "where do you get bad wire around this mill with which to demonstrate?"

Our guide hesitated, gulped — then a smile broke over his face: "Why, this is B's (rival company) best grade of wire, which we buy for this purpose."

Ah, Glamour, Why Has't Thou Gone!

A lovely lady, with chic hat and well dentifriced teeth, orchid on left breast, stands up there on a platform smiling at some face-weathered admiral. In the background a 10-piece orchestra is playing: "Anchors Aweigh." A bell rings and the chairman whispers: "Now." The lovely lady takes a swing and glorious brown fiz shoots all over the prow. Then the ship starts gliding down the ways. That is glamour!

Now step with us to the yards of the Consolidated Shipbuilding Corp., Morris Heights, N. Y. A barge is about to be launched. Up near the prow is a contraption consisting of a pivoted arm held horizontally by a spring catch. A bottle of champagne is attached to the end of the arm with the customary ribbons. The hull starts to slide. The catch is released and the robot sponsor, "Christine," as the boys call her, splashes champagne with precision. "Christine" has never yet missed. But is that glamour — we, the editors, ask you, the readers?

Thoughts on Production

Our monstrous war output never bores in the telling. After years at slightly under full capacity, the steel industry reached 100.0% beginning April 24. Operation of the industry under the 48-hr. week order of May 1, 1943 saved 47,500 men for other industries—and during a period when new production records were made.

America has already produced 20,000 vessels. When the program is completed, we'll have 80,000 landing craft of 15 special types. "Our ordnance as a whole has a substantial advantage in combat over the enemy." The British say our tank performance is magnificent.

The "NE" and Other Alloy Steels

It can be said with confidence that our survey, on other pages, of the status of the National Emergency (NE) steels after the war proves conclusively that the American alloy steel industry in the post-war era will not by any means be of the same character as before the war, at least for some time.

While the replies to our questionnaire are by no means unanimous in their appraisals, the preponderance of opinion is that the NE steels will be used extensively for some years at least, and that the older, high alloy steels will regain only a part of their former relative position. This means that the alloy steel in industry as a whole will for sometime be more complex than formerly — with the gradual reintroduction of some of the older, higher alloy steels.

How long this situation will prevail it is difficult to say. In appraising this, consideration should be given to the fact that the introduction of any new steel, NE or others, is always difficult at best; that the pressure from producers of alloying materials will be quite intense and to some extent successful; and that there will be a strong inclination by many of the users of the old steels to employ them again. Many of the replies emphasize the effect of the price situation and of the quantity of nickel-chromium-molybdenum and similar scrap available. Both of these factors will cogently affect the post-war readjustment.

One definite result of the development and use of the NE steels is the broader knowledge obtained about the effects of various alloying elements in alloy steels and about their heat treatment. This will tend to create a greater use of alloy steels in general. Undoubtedly the alloy steel industry is headed toward a broad expansion when economic and commercial conditions become normal.

—E. F. C.

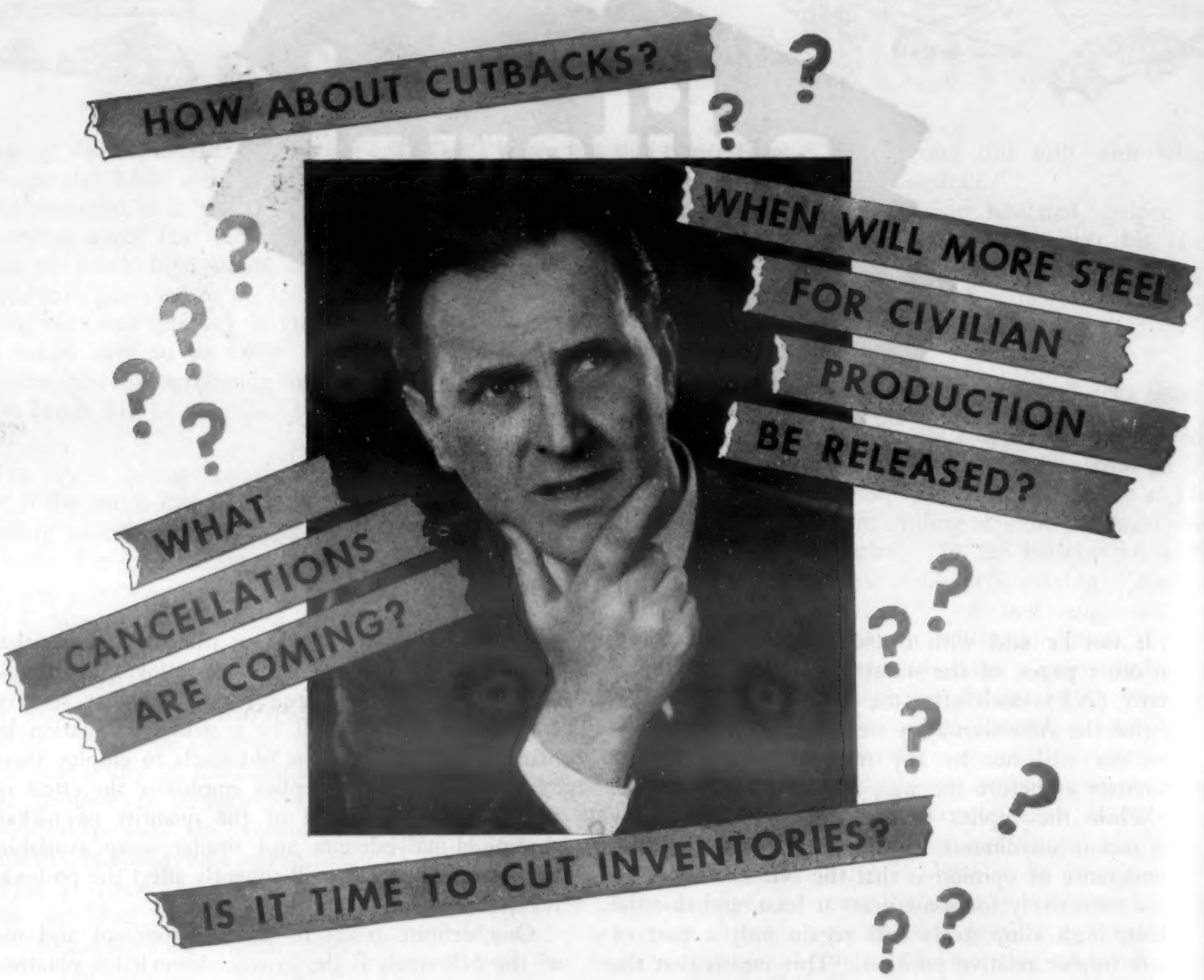
Lead Looks Ahead

Of all the nonferrous metals lead appears to be in about the best position from the standpoint of its manufacturers. Throughout the war it was the "most available" metal we had, hence was substituted for other materials on a very wide scale and many engineers got to know lead and to like it better. In spite of this expansion in use, however, the producing industry is not at all over-extended, and at the present time only 40 per cent of lead's consumption is supplied by domestic primary metal, the bulk of the raw material being secondary and imported metal.

In war or peace the greatest tonnage of lead goes into storage batteries, with cable sheaths, buildings (pipe, flashing, etc.) and ammunition also taking large amounts. The ammunition consumption of course will drop when the war is over, but everyone is sure that the outlet for lead in storage batteries will be greater than ever because of the automobile demand (6 million cars per year means a lot of lead storage batteries!) Public utility lines will be installed at a heavy rate, most experts agree, thus "setting up" the cable sheath application for some time to come. And the building boom seems, happily, to be a foregone conclusion.

In the area of its "substitute" applications, lead may lose much of its new-found market in high-lead, low-tin or tinless solders when postwar workers (except in the canning industry) go back to the more popular solders of old. But lead will "stick" in the high lead bearings and especially in lead-coated steel sheet — the latter a vast new field the peacetime opportunities in which may be among

(Continued on page 1121)


HOW ABOUT CUTBACKS?
WHEN WILL MORE STEEL FOR CIVILIAN PRODUCTION BE RELEASED?
WHAT CANCELLATIONS ARE COMING?
IS IT TIME TO CUT INVENTORIES?

Here are the facts . . .

● Many companies in the metal-working industries have recently experienced cutbacks in war contracts and there is some evidence of planning for partial reconversion to commercial production. As a result, a number of manufacturers are already circulating lists of odd steel stocks and excess inventories. More lists will appear as cancellations, design changes and manufacturing trends follow the tide of war.

While there is no real surplus of steel at the present time, there are sound reasons for a conservative buying policy. First, you will help war production by making steel available for those who need it immediately. Second, it is good business to keep your inventory at a practical working level.

Steel overstocks may be dynamite. Cancellation of a contract or a change in design can overnight leave you with an excessive or obsolete steel inventory. There was a time when this conservative inventory policy might not have been sound from a production standpoint. However—most warehouse stocks have been built up so they now can quickly meet any demand.

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BARS • SHAPES • PLATES • SHEETS • TUBING • STRUCTURALS • CARBON AND ALLOY STEELS • TOOL STEEL • ALLEGHENY STAINLESS

RYERSON STEEL-SERVICE

the most significant for lead; new lead coating alloys and more efficient methods of applying them have caused a swing to this type of sheet construction on a quality-and-cost basis that is much stronger than mere wartime substitution.

The chemical-plant uses of lead may drop, but there is one new application — the use of lead-foil-coated paper wrappings for food, drugs, industrial parts, metal products, etc. — that should more than offset this deficit. The ordinary "lead-foil" application, though, will meet tough competition from aluminum; on the other hand the use of lead in collapsible tubes should continue to grow.

Other important new uses are the employment of lead balance weights in airplane construction, and the development of a non-corroding steel-reinforced lead battery terminal said to be capable of completely replacing the familiar copper terminal for automobile batteries.

All of which means that the statement by a leading aluminum manufacturer in one of its advertisements that "lead carries weight" was no idle gallantry, but a bit of respectful tribute to the weight — physical and commercial — that lead can be expected to carry in the industrial world-to-come.

—F. P. P.

Engineering In Post-War Russia

Engineering in the post-war Soviet Union will be on a higher level than before, perhaps extending into international fields, according to Andrew J. Steiger, journalist and writer on Russia. Very few American engineers will travel to Russia under contract. There will be an increasing migration of machines, rather than of men to make them.

When American engineers under Col. Hugh Cooper were building the great American-designed Dnieper Dam, Col. Cooper asked for more American engineers on the job, said Mr. Steiger. Stalin refused, saying that even if the project cost more, it was worth it as a training school for Russian engineers. The labor turnover on the project was very high — about 60 per cent — and the men trained there later became Russia's leading construction engineers.

Using foreign technical aid, Russia established her own industrial plant and also trained a corps of her own engineers to operate and manage it. This was the aim from the beginning, and the Dnieper Dam project was a model followed in later works. When Russia establishes her own complete machine-tool industry she will be entirely independent of the rest of the world, industrially.

—K. R.

Unbalance in the Steel Industry

An important question of post-war outlook is to what extent the steel industry is out of balance as to type of mills and equipment. After the first war there was too much plate making and shipbuilding capacity. Many shipbuilders turned to fabrication of structural steel when peace came. The steel industies were out of balance for war production in 1940, with a plethora of stamping equipment and scarcity of forging equipment, to use opposite examples.

Again, plate-making capacity will have been found too large when reconversion to peace takes place. In this war ships have not only been used to transport soldiers and supplies, but landing and amphibious ships have performed in direct warfare operations. Plate making capacity may at first blush seem the most grossly overbuilt of all. Yet much of our plate has been turned out on continuous strip and sheet mills. These can be converted back to strips and sheets easily.

Automobile manufacture certainly will take up the capacity of the strip mills that are now rolling plates. Some of the eastern plate mills are antiquated and virtually obsolete, having already produced their normal period of years and will logically be retired. Two new plate mills in the Far West, however, may find it hard sledding to retain their outlets.

At the other end of the scale are rail mills in which there has been little, if any, expansion. After the war there should be an increase of rail making on present mills to build up depleted carrier equipment. But present rail-making capacity may not need to be expanded. The tendency will be towards longer lasting rails and lighter rolling stock, both factors favoring adequacy of present rail-making equipment.

Tin plate making equipment might seem of right size. Point rationing of civilians may have offset larger production for armed forces. Blooming mill equipment is still a bottleneck, hence not greatly, if any, overexpanded for peace. Iron ore mining and transportation on an annual basis of 90,000,000 tons might seem considerably on the over side, especially in view of huge quantities of battlescrap.

Fabricated structural steel facilities would seem about normal, as are sheet, bar, and wire making capacities. Undoubtedly open-hearth and electric furnace capacities are large. Blast furnace sales have been unrestricted for several months, indicating most liberal capacity on pig iron.

Undoubtedly the management of many a large diversified company is doing much thinking along these lines today and planning where the sharpest curtailment of facilities will be made. They are keeping a sharp eye, too, on competitive materials.

—H.A.K.

Hot-rolled NE alloy steel bars of various sizes and analyses, ready for fabrication into machinery pa and war products. (Courtesy: Jos. T. Ryerson & Son, Inc.)

The N. E. Steels in the Post-War Era

—A SURVEY OF LEADING OPINION

by EDWIN F. CONE

Today the primary question about NE steels in the minds of industry's engineers is not "how shall they be heat treated?" nor "what is their relative machinability?" nor indeed "are they useful engineering materials?" but actually "are they here to stay or will they be largely replaced after the war by the old, higher alloy steels of the S.A.E. type?" Mr. Cone has sought the answer to this and subsidiary questions among the country's leading materials engineers and metallurgists and reports his findings in this article. The ultimate answer is of vital interest to a variety of groups — not only the men who must specify materials to build the vehicles, machines and other products of the future, but the men who will produce our steels, provide our melting furnace equipment, design our heat treating furnaces, manufacture our alloying agents, and so on.

—The Editors

REALIZING THAT THERE IS a keen general interest in the part which the National Emergency (NE) steels may play in industry after the war, the editors of METALS AND ALLOYS have conducted a survey of responsible opinion, a summary of the results of which is offered in this article.

The NE steels were developed in 1941 by a group of leading metallurgists to take care of an emergency — the lack of certain critical alloying elements. They are in general a series of steels containing small amounts of two or three alloys such as nickel, chromium, molybdenum and manganese instead of larger quantities of only one or two alloys. They have been and still are very successful and have stood the test of actual combat in tanks, gun parts and other munitions.

Some measure of the extent to which these NE steels have been and are being used is afforded by the fact that the American Iron and Steel Institute estimates that more than 4,000,000 net tons, or about one-third of the total alloy steel output, in 1943, was NE steels of various types. This is estimated to have saved the nation many tons of nickel and other critical alloying elements.

An important factor, as brought out in this survey, is that in the manufacture of these NE steels, full use is made of the alloying metals available in scrap. It is estimated that as much as 30% of the chromium content, 25% of the molybdenum and 50% of the nickel requirements are obtained from the charges of selected alloy steel scrap which go into the melts. These steels are made either in open-hearth or electric furnaces but most of them are open-hearth steels.

The four questions which constituted the basis for the survey are found in another column. These questions were sent to 73 metallurgists, metallurgical engineers, materials engineers, and other influential engineering authorities and each one was assured that their replies would be regarded as strictly confidential and that any quotations would be used anonymously.

It is gratifying to report that more than ordinary cooperation was achieved. A total of 43 replies were received, which is 58.1% of the total sent out — a splendid response. This fact and also the consideration that the replies came from leading metallurgists and materials engineers, both producers and users of the NE steels, make the value of the survey all the more important.

Taking up the questions in their order and analyzing the general trend in the opinions expressed, the results of the survey speak for themselves. They are summarized in the following paragraphs.

I. Extent of Use After the War

Opinions vary quite markedly as to the extent of the use of the NE steels in the post-war period. The majority agree that they will be used more or less extensively. Several emphasize the point that the economics of the situation will be a determining factor, *i.e.* the price of these steels.

One well-known metallurgist says they will be used "a great deal if, and only if, the prices are brought

THE FOUR QUESTIONS

I. To what extent do you expect the NE steels to be used after the war?

II. Which of the various types have the best future?

III. If there is likely to be a decreasing relative demand, what would you say were the causes?

IV. Will the older or higher alloy steels resume their relative place in industry?

THE CONSENSUS

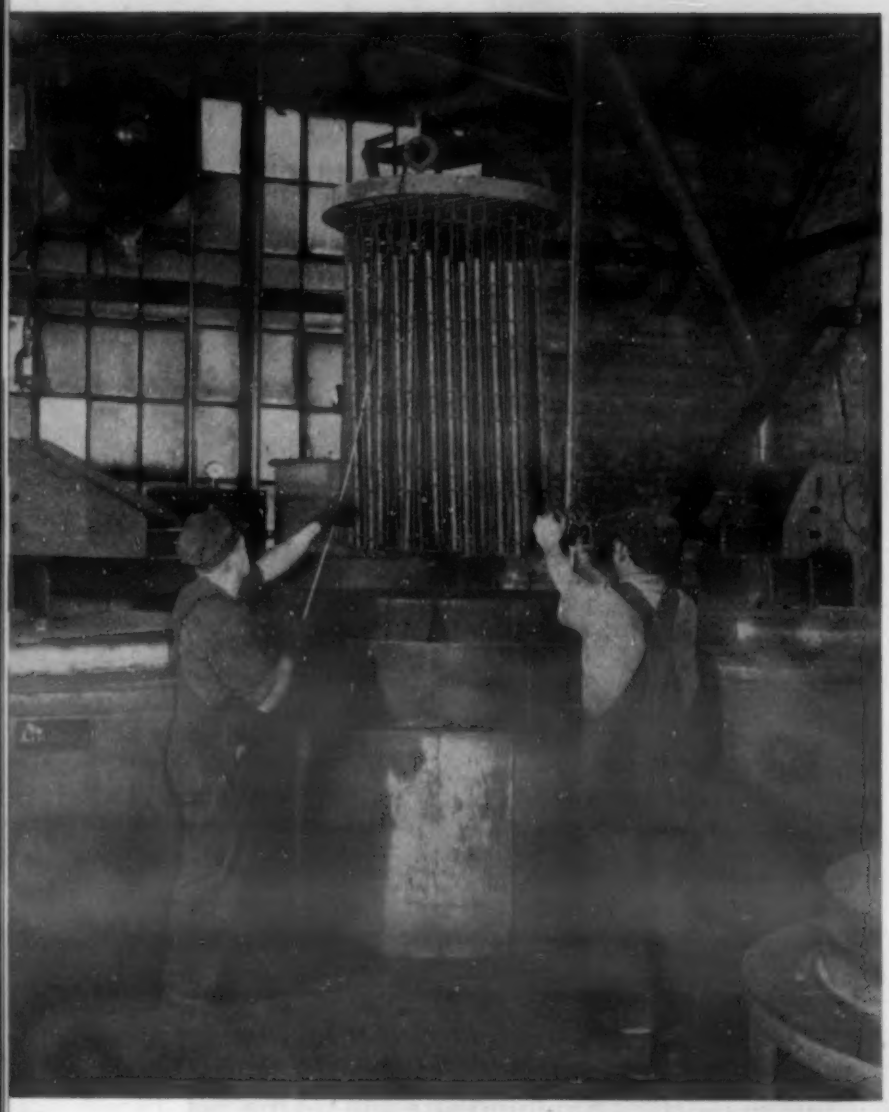
On the basis of the survey reported in this article, the editors of METALS AND ALLOYS offer the following conclusions as a preview of the future of the NE steels:

1. As a class the NE steels are here to stay, although the extent of their use will be lower than at present. Price factors as much as anything else will set the level of their ultimate use.

2. The 8600 and 8700 series are expected to be the "fair-haired" boys among them. Some of the others—e.g. 8900 and 9600—may pass out of the picture.

3: The reasons for a lessened relative post-war demand will be (a) the fussier heat treating behavior of the NE steels, (b) the psychology of favoring the familiar over the new or strange, (c) NE steel overpricing, so that either the lower prices of the "needled" carbon steels or the better properties of the higher alloy steels become more attractive, and (d) sales pressure from the alloy producers.

4. The older, high-alloy engineering steels will regain some (perhaps much) of the ground they lost during the war, but will probably not resume their former relative position.



Typical of the tie up between NE steels and modern heat treating methods is the hardening of NE 8750 tank track pins at an Indiana plant. These pins are being hardened at 1525 F. in a high-temperature forced convection furnace. (Courtesy: Lindberg Engineering Co.)

into line." A metallurgical engineer, very closely connected with the aircraft industry, replies that these "steels will be used after the war since the scrap situation will be as it is at present, *i.e.* a high percentage of alloy scrap will contain chromium, nickel and molybdenum. There will however, be considerable resistance to the use of these steels unless the price is in line with other alloy steels which produce equivalent properties."

From a metallurgical engineer prominent in the tractor industry comes the word that "the persistence of the ternary alloy steel types after the war will be both desirable and economically justifiable provided a reasonable differential is maintained in the pricing situation." Another engineer close to the development of these steels, feels that in the higher carbon grades the matter will be one of economics rather than the use of some specific or group of elements. The NE grades will probably be used by users who have not dealt with alloy steels before. Considerable carburizing grades will be used by gear makers and perhaps bearing manufacturers, particularly NE 4700, not a published grade.

The director of research of a large steel producer feels that the extent to which the NE steels are used after the war will be largely dictated by the economics of the chemistry, the processing, fabrication and heat treatments into the final product. How the economics will align themselves as between various chemistries is difficult to predict at this time, he feels.

The use of NE steels after the war will be conditioned by two factors: The scrap situation and the price picture. The scrap situation will tend to keep the NE steels in the foreground; if the present price set-up continues, however, many customers undoubtedly will insist on returning to SAE types — according to the opinion of the members of a prominent research laboratory.

It would be both profitable and interesting if we could quote in full a reply that came from a well-known metallurgical engineer who never "holds his punches" and whose pronouncements are always frank and sincere. He says that our questions probably refer to the NE steels and not the "needled steels." "In my mind I throw them both in the same pot." He believes both types of steel will find considerable use after the war by those plants employing good metallurgical departments — or the automotive and agricultural implement fields. In such large fields as the railroads, machine tools, aircraft and diesel engines and chemical engineering equipment fields, "I doubt whether they will be used much. These industries are run by engineers who listen to no metallurgists and who get all their answers from the handbooks they used in years gone by. A considerable tonnage of the NE steels will be used provided the steel industry does not undertake to kill them." He also says that if the steel industry wants as much money for the low alloy, complex NE steels as for the higher alloy, more simple older steels, the tendency will be to go back to the old.

A representative of a large company making some of the regular alloying elements says that it is his personal opinion that the nickel-chromium-molybdenum steels with high manganese will be among the important ones that remain. These and also the lower manganese steels plus intensifiers will come to the fore according to the trend of two commercial features, *i.e.* scrap prices and established steel prices.

From a very large electrical equipment company which has used a considerable tonnage of the NE steels "with generally satisfactory results" comes testimony that these steels will be used to a considerable extent after the war. "It will be difficult to justify the return of the more highly alloyed steels of prewar days except for applications requiring heavy sections or certain special properties."

It would be a very serious reflection on American steel metallurgists if these steels were to fall into disuse as the conditions which prompted and necessitated their development became less stringent, says a metallurgist who is highly respected for his good judgment. "Their development is one of the outstanding metallurgical accomplishments of the war."

Some of the NE steels will be continued in use, says the head of the metallurgical department of a large company. In his opinion the use of chromium,

nickel and molybdenum in the proportions specified in these steels "is a logical procedure, not only because it conserves alloys by using them in the proportion most frequently found in scrap alloy steel but because this combination of alloys seems to be technologically correct in that the greatest advantage is derived from a hardenability standpoint and also from the standpoint of good physical properties."

Not only on account of the scrap situation but also because some people will have learned that the lower alloy steels will satisfy their design requirements, the NE steels will be used to some extent after the war, in the opinion of a metallurgical engineer associated with a large producer of automobiles. And another engineer says: "Undoubtedly some of the NE steels will remain in use after the war because they should be cheaper; they offer good physical properties for many engineering applications."

More testimony of a similar nature to those already cited could be quoted — the predominating opinion was of this character. Out of 29 replies of those expressing an opinion, 26 testified that the steels would be appreciably used in the post-war era.

There were very few replies contrary to the prevailing testimony. One well-known metallurgical engineer, the chief metallurgist of a very large steel company, replied that their use would be "small." A member of the staff of the research department of a large oil company expects "the use of the NE steels to decline sharply as soon as restrictions on the use of alloys are removed. The first decline will be followed by a more gradual decrease in use as price differentials become less and normal competitive conditions are restored."

II. Which Types Have the Best Future?

An analysis of the replies to our second question shows a preponderance of opinion in favor of the chromium-nickel-molybdenum type as the one or ones most likely to be used after the war. There were 5 "votes" recorded for this type as a general class with 19 votes for the 8600 series and 14 for the 8700 series. The 9400 type received 6 votes and the 9500 series 4 votes while one vote was recorded for each of the 8900 and 9600 series.

A few of the most interesting and significant comments follow:

The director of metallurgy of a large company believes that the chrome-nickel-molybdenum NE steels such as NE 8600 and 8700 will be used quite extensively for three reasons: (1) There is now and will be after the war a tremendous amount of this type of scrap; (2) these steels have been found to be very satisfactory in service and a large number of companies have found them comparatively easy to put into production; (3) their machining and heat treatment is no more difficult than the steels they replaced.

Probably the NE 8600 series (Cr-Ni-Mo) in both

SOME HIGHLIGHTS OF INDIVIDUAL OPINIONS

"If the NE steels can be priced to make their low alloy content attractive, they will find a good market. Priced up with the SAE types, most of them have not been shown to have sufficient merit to make them competitive."

"So much has been learned in the last few years concerning the effects of the various alloying elements and about methods of handling alloy steels that when economics again become predominant we can expect still further changes in the alloy steel picture."

"Post-war uses of alloy steels for all purposes will be more general than in the pre-war period. There will be a marked increase in demand in the light weight structures field."

"Why should the steel industry take such a stand (*i.e.* ask as much money for the low alloy complex NE steel as for the higher alloy, more simple, older steels)? For at least three reasons: First, few elements of composition to analyze and control; second, pressure from the alloy suppliers; third, a desire to get out from under the responsibility of supplying a different material and being blamed for everything wrong in the kitchen sink."

"The extent to which we will use the NE steels after the war will depend upon their general availability. If they are as difficult to obtain then as they are now, little use would result."

"Undoubtedly there will be a desperate effort by the interested producers of steel alloying metals to resell the American user on the advantages of the older or more conventional type of alloy steel. Some success in this direction must be expected."

"While the older and more highly alloyed steels will continue to be used for special applications involving heavy sections, they are not likely to resume their relative place in industry. Among them the steels of the SAE 4100 series seem to have the best chance for a comeback."

"There will be a return to the higher alloyed steels, but whether or not it will be a return to the conventional lists that we know today is problematical. Many of our hallowed theories relative to alloy steels have been exploded during the war, much new knowledge has been gained, new personalities have entered both the producing and consuming fields, and there is no doubt that there will be some changes."

carburizing and full-hardening grades will be the types used after the war. In addition the high-hardenability 9500 and 8900 steels (Mn-Cr-Ni-Mo) should have a good chance of survival in the opinion of the staff of the research laboratory of a large steel company.

The opinion of the chief metallurgist of a producer of motor vehicle parts is to the effect that the 8600 and 8700 series are preferred over any of the other NE steels. "There will naturally be a number of old conservative manufacturers who will want to return to the old high alloy steels." The chief metallurgist of another producer of motor vehicle parts feels that the types that will have the best future will be the carburizing types of the 8600 and 8700 steels and the water and oil hardening types in the 8600 series; he believes that the popularity of the 8600 series will exceed that of the 9400.

From the research department of a large oil company: "The full hardening grades 8600 and 8700 series have the best future. The carburizing grades of all series have the least promising future. It is probable that the 9500 series will find some use in the replacement of carbon steels."

The nickel-chromium-molybdenum types will be the most popular since these afford excellent physical properties, according to an engineer with a leading producer of electrical equipment. "We can expect that the available scrap will for some time contain relatively high percentages of these alloying elements, making it very desirable from a steel melting standpoint to use this scrap to the best advantage. This may mean that the present 8600, 8700, 9400 and the older 8900 types will be merged for one type having a wide range of usefulness."

A few opinions selected at random are the following:

"The 8600-8700 series seem to have the best reputation: 9400 and 9500 are not popular and have been freely criticized."

"The types which we feel will be most popular will be 8600, 8700 and 9500, particularly for aircraft and gears."

Selecting the 8600 and 8700 series as most likely to persist — "we do not believe there is much future for the 9400 series in view of the tendency for phosphorus reversion in the open-hearth when high silicon is employed."

"The three alloy types as represented by the 9400, 8600 and 8700 steels will have the best future, at least for low alloy structural steels such as used in aircraft structures, parts and accessories."

"The steels which will remain with us will probably be 8720, 8620 and 8630. Those steels have proved themselves in so many applications that their post-war use seems assured. There is a possibility that, with some adjustment in composition, 9440 will also remain in a limited tonnage field," according to a metallurgical engineer closely associated with these steels from the beginning.

III. Factors that May Limit Relative Post-War Demand

Opinions expressed by the authorities who replied varied quite markedly but most of them emphasized the factor that economics or the price situation will affect the relative demand for the NE steels after the war. This is analogous to the replies to the first of the four questions — the price situation and its effect on the extent to which these steels will be used in the post-war period. In both cases there was found to be strong emphasis on this point.

For example — "The way that the pricing situation is handled by the steel companies will have a tremendous influence on the permanence of this series of steels as, of course, it will also on the old SAE types or any new types that may come out in the future" according to one prominent engineer. "One thing that is perhaps out of line in connection with these steels, as it is in connection with most war production, is the economic phase."

The materials engineer of a large organization says that "the demand for the NE steels will fluctuate with the cost. As the older high alloy steels become available, it is likely the NE steels will be cheaper and that may cause them to be used for many purposes. I think the price charged for the NE steels will largely determine their future."

"The economics will be the most critical phase of the whole picture," says the chief metallurgist of a large manufacturing company, "since single alloy types with the use of special addition agents will easily overcome the mass effect where higher alloys were formerly necessary. This, again, is going to be dependent upon the pricing situation.

A metallurgical engineer with a large automobile manufacturer believes that there will be a decreasing relative demand as the scrap situation changes because (1) there will be a tendency to get away from complex alloy additions and to use one or two alloys rather than three; (2) the price is too high; (3) it takes a long time to establish a market for a new steel; and (4) the chemistry and hardenability limits are so extremely wide as set up by A.I.S.I. that the consumer, who is interested in hardenability, will not be willing to accept this wide range in the post-war period.

Again the question of price enters the picture — "the price angle will naturally become more important" — says a materials engineer of wide experience in the aviation field. "The demand for NE steels may be affected by the tendency to promote proprietary steels on the part of the steel companies, and the introduction of 'needled' steels at a lower price."

As the director of research of a large company sees it, the decreasing relative demand will be the result of the difficulty on purely economic grounds of deflecting alloy-containing scrap into furnaces making the same alloy types. The cost of transportation of scrap from points of generation to points of

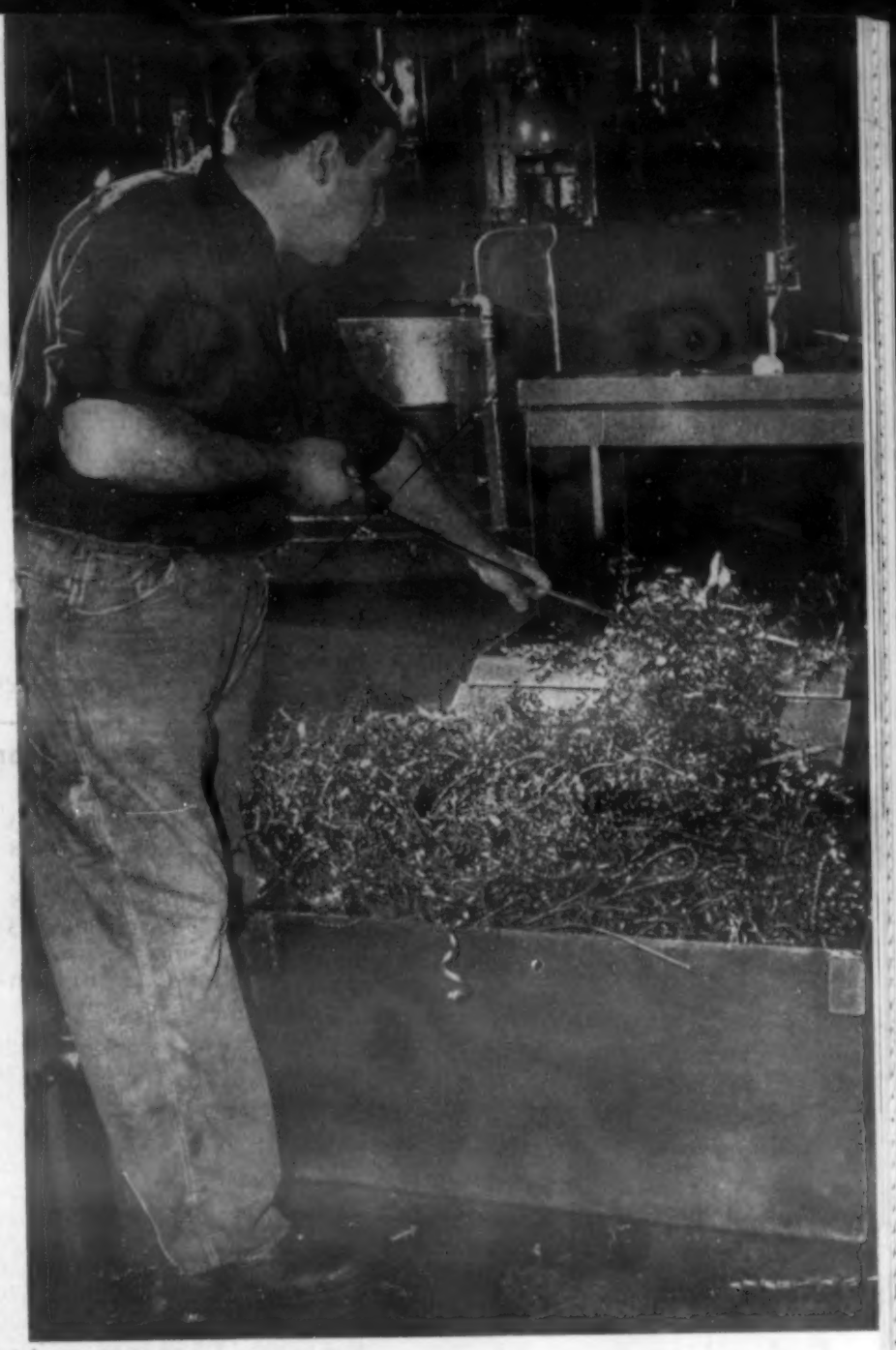
consumption, will be a major factor. This will result in ultimate dilution. "Low alloy steels involving 3 or 4 alloying elements will remain but I believe that the compositions and properties will be modified according to desired uses rather than being dictated by scrap availability. In creating these combinations, the hardenability intensifiers will play a significant part for they appear to be here to stay."

That there "will certainly be a decreasing relative demand" is the opinion of one prominently connected with the development and promotion of the NE steels. One of the major reasons, he writes, will be the lack of "insurance policy" in the steels, that is, "their heat treatment ranges are closer than those of the higher alloyed steels. Therefore, they are not quite so foolproof, particularly in shops which do not have the most modern heat treatment equipment."

An interesting statement comes from the materials staff of a large company: There will be some decrease in the relative demand for these steels due to the better understanding of the proper application of both carbon and alloy steels. "The field of application of the plain carbon steels will certainly be enlarged since during the war carbon steel has been found adequate for many applications where the use of alloy steel was formerly considered necessary."

The director of metallurgy of a large company offers the following reasons for a likely decreasing relative demand: Inferior service life, difficulties in production such as machining and heat treatment, or scarcity of scrap suitable for such steels. Another metallurgical engineer and user of these steels says a reason for decreasing relative demand will be the fact that the NE steels are inferior in some respects to the pre-war steels; that short time experience will not overcome the confidence of many years' experience with the pre-war steels; and that price differential will not be enough for their undiminished use.

One of the leading metallurgical engineers of the country answered Question No. 3 with one word — "Price," and two other well-known engineers emphasized the influential role that "sales pressure by alloy manufacturers" will play.



Created to utilize most efficiently the residual "alloy" introduced through scrap, the NE steels will also find their futures dependent on the post-war scrap situation. Here is shown a machine operator at an aircraft engine plant transferring segregated nickel-chromium-molybdenum steel shavings into a portable salvage receptacle. (Courtesy: Wright Aeronautical Corp.)

IV. The Place of the Older Alloy Steels in the Post-War Era

There were many conflicting answers to our fourth question — the relative place in industry of the older or higher alloy steels after the war. Some feel that they will resume their old role while others insist that they will not or certainly only partially. The preponderance of those who expressed an opinion was to the effect they would not resume their relative position. Some of the replies of the latter trend are as follows:

"I do not believe that the older or higher alloy steels will resume their relative place in industry because so many applications have proved successful with the use of the NE steels and in a great many instances have brought to light that the higher alloy pre-war steels were not required."

"The old 'sales talk' of loading steels with alloy for factors of safety and ignorance in handling has received such a severe jolt by the lean alloy steels of the NE grades that it is unlikely that the higher alloyed steels of former times will be in demand."

"I do not expect that the older or higher alloy steels will ever resume the place they held previous to the war. This is because so many people have learned to get more physical properties out of the steels and, in addition to use alloy steels somewhat closer to their physical properties rather than to utilize such a high factor of safety."

"The pre-war steels will not attain quite the same relative position in industry. A few of the better NE steels will be used and the intensified steels are here to stay and they will force their way into the picture probably largely at the expense of the higher alloy steels."

"War conditions have so broadened the horizon

of the steel metallurgist and challenged his basic ideas in alloy steels that a blind return to the easy 'spend-thrift' ways of pre-war metallurgy is unthinkable."

"We do not believe that the older alloy steels will ever occupy the place they formerly held. The scrap situation will of course be one factor in this."

Among the few who disagree with those already quoted, that is, who feel that the older steels will resume their relative position, the following quotations are of interest:

"The higher alloy steels will resume their relative place in industry. In fact at the present time, changes are being made to higher alloy steels in order to obtain the combination of depth hardenability and ductility in heavier sections which up to the present time can only be obtained by the addition of alloys."

"I feel that the older or higher alloy steels will resume their former place in industry. The general trend in mechanical design is toward higher speeds, greater stresses, higher temperatures, and consequently the best possible steels must be used."

"I look for an increase in proportion of alloy steel due to weight consciousness."

Present National Emergency Steel Compositions

Carbon-Manganese Steels

	C	*Mn*	*Si*
NE 1330	0.28/0.33	1.60/1.90	0.20/0.35
NE 1335	0.33/0.38	1.60/1.90	0.20/0.35
NE 1340	0.38/0.43	1.60/1.90	0.20/0.35
NE 1345	0.43/0.48	1.60/1.90	0.20/0.35
NE 1350	0.48/0.53	1.60/1.90	0.20/0.35

Nickel-Chromium-Molybdenum Steels

	C	*Mn*	*Si*	*Cr*	*Ni*	*Mo*
NE 8613	0.12/0.17	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8615	0.13/0.18	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8617	0.15/0.20	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8620	0.18/0.23	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8630	0.28/0.33	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8635	0.33/0.38	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8637	0.35/0.40	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8640	0.38/0.43	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8642	0.40/0.45	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8645	0.43/0.48	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8650	0.48/0.53	0.75/1.00	0.20/0.35	0.40/0.60	0.40/0.70	0.15/0.25
NE 8720	0.18/0.23	0.70/0.90	0.20/0.35	0.40/0.60	0.40/0.70	0.20/0.30

Silicon-Manganese and Silicon-Manganese-Chromium Steels

	C	*Mn*	*Si*	*Cr*
NE 9255	0.50/0.60	0.70/0.95	1.80/2.20	—
NE 9260	0.55/0.65	0.70/1.00	1.80/2.20	—
NE 9261	0.55/0.65	0.70/1.00	1.80/2.20	0.10/0.25
NE 9262	0.55/0.65	0.70/1.00	1.80/2.20	0.25/0.40

Manganese-Nickel-Chromium-Molybdenum Steels

	C	*Mn*	*Si*	*Cr*	*Ni*	*Mo*
NE 9415	0.13/0.18	0.80/1.10	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9420	0.18/0.23	0.80/1.10	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9422	0.20/0.25	0.80/1.10	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9425	0.23/0.28	0.80/1.10	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9430	0.28/0.33	0.90/1.20	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9435	0.33/0.38	0.90/1.20	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9437	0.35/0.40	0.90/1.20	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9440	0.38/0.43	0.90/1.20	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9442	0.40/0.45	1.00/1.30	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9445	0.43/0.48	1.00/1.30	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9450	0.48/0.53	1.20/1.50	0.20/0.35	0.30/0.50	0.30/0.60	0.08/0.15
NE 9537	0.35/0.40	1.20/1.50	0.40/0.60	0.40/0.60	0.40/0.70	0.15/0.25
NE 9540	0.38/0.43	1.20/1.50	0.40/0.60	0.40/0.60	0.40/0.70	0.15/0.25
NE 9545	0.43/0.48	1.20/1.50	0.4000.60	0.40/0.60	0.40/0.70	0.15/0.25
NE 9542	0.40/0.45	1.20/1.50	0.40/0.60	0.40/0.60	0.40/0.70	0.15/0.25
NE 9550	0.48/0.53	1.20/1.50	0.40/0.60	0.40/0.60	0.40/0.70	0.15/0.25

Carbon-Chromium Steels

	C	*Mn*	*Si*	*Cr*	*Ni*	*Mo*
NE 52100A	0.95/1.10	0.25/0.45	0.20/0.35	1.30/1.60	0.35 max.	0.08 max.
NE 52100B	0.95/1.10	0.25/0.45	0.20/0.35	0.90/1.15	0.35 max.	0.08 max.
NE 52100C	0.95/1.10	0.25/0.45	0.20/0.35	0.40/0.60	0.35 max.	0.08 max.

Machining the formed pieces. A Carboloy tool is used to cut the hard metal, while a guide gives the parabolic contour.

Formed Stellite Reflectors for the Navy

by HENRY G. HORNER

Supt. Searchlight Reflector Project, Chrysler Corp., Detroit.

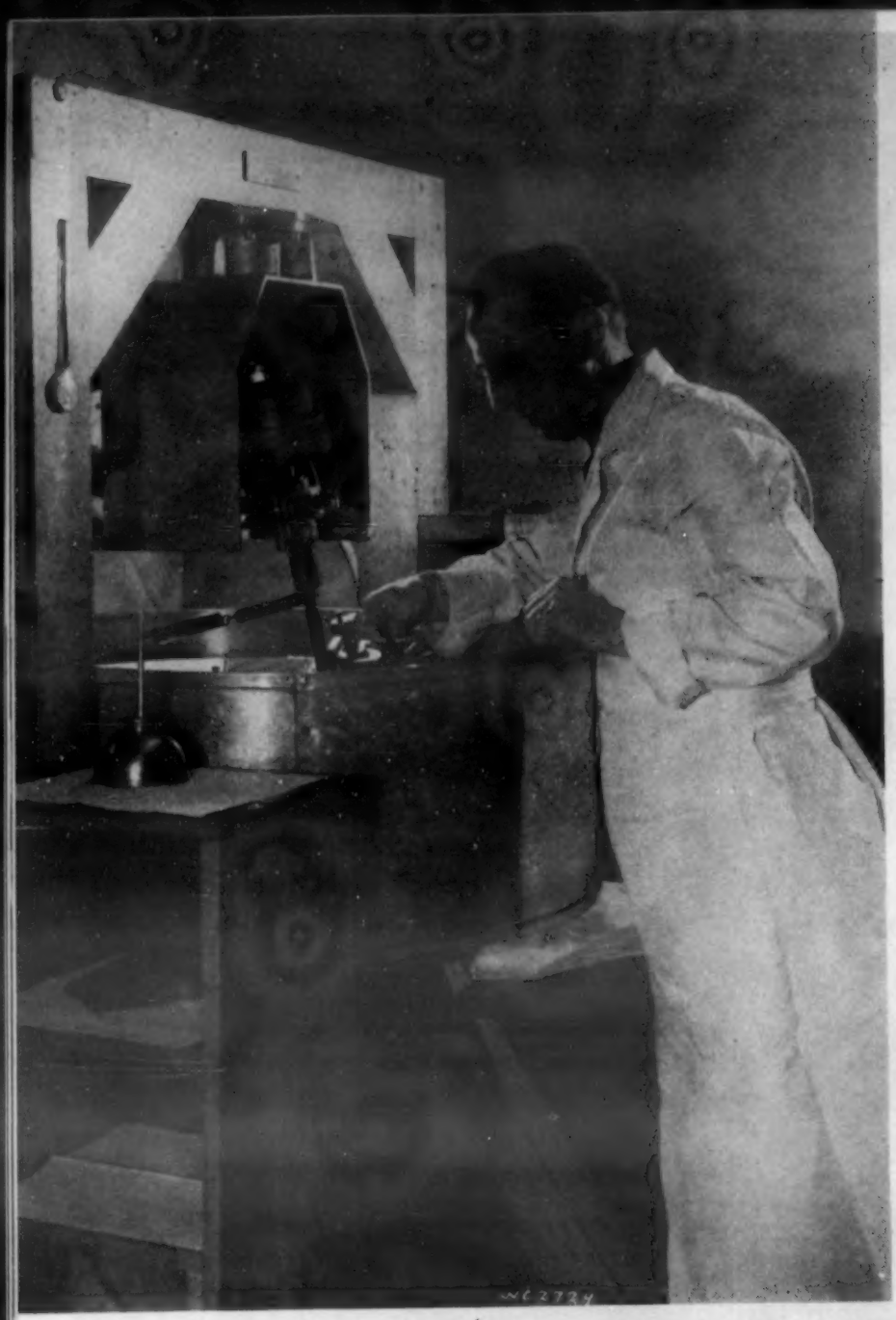
Of interest to both design and production engineers is this first-time description of a significant wartime innovation — the use of ultra-hard non-ferrous alloys of the Stellite type for large Navy searchlight reflectors and the attendant development of methods of hot-rolling, hot-forming and finishing. This article reviews the service requirements, the fabricating and finishing operations and the inspection methods involved in this application.

—The Editors

SEEKING A METAL to meet a difficult combination of requirements, the United States Navy finally hit upon the heat- and corrosion-resisting Stellite alloys for reflectors for its searchlights. Several thousands of the reflectors have been produced in these metals, and have been accepted for service.

Requirements for Navy Reflectors

Parabolic reflectors for Navy use were needed in 12-in., 24-in., and 36-in. nominal sizes, the actual diameters of the discs to be about 1½ in. larger than these dimensions. Service conditions were ex-



Superfinishing smooths out the machined surface while keeping the parabolic form.

A final polishing operation with a loose abrasive provides the mirror finish. The high reflectance of the piece in the machine is evident.

tremely severe. High resistance to corrosion by salt air, salt spray, powder fumes, and sulphur fumes was a basic requirement. High reflectivity was also a prime essential. The material was required to be non-shattering, so that the shock of gunfire would not cause damage, and to be of such a nature that hot particles of carbon and copper from the searchlight electrodes would not cause pitting of the reflecting surface. Since the reflector must function in close proximity to the arc, sometimes for protracted periods of time, it must be resistant to oxidation at high temperatures. The material was also required to be so hard that repeated cleanings would not mar the surface.

Many of the commonly used reflector materials are obviously unsuited for such severe service. However, trials were made with various metals, plated with silver or chromium. The short periods over which these reflectors maintained their efficiency prompted experiments with the Stellite materials.

The alloys were found to be free from the pitting difficulties of other materials. Particles of electrode materials spattered onto the reflectors could be removed by wiping the reflecting surface with a cloth soaked in dilute nitric acid. The high operating temperatures caused no scaling of the metal. Several months of outdoor exposure in Washington, D. C., caused no change in reflectivity.

While Stellite alloys have been used for many years for cutting tools, for surgical and dental instruments, for small scientific mirrors, and many similar purposes, they were never before used in such large parts requiring forming, machining, and polishing. The material must first be prepared in sheet form, then blanked out and dished to roughly parabolic shape before machining and polishing. It was decided to use Stellite No. 6 for the 24-in. and 36-in. pieces and Hastelloy C for the more severely worked 12-in. reflectors. The No. 6 metal, a cobalt-chromium-tungsten alloy, is the only one of that series malleable enough to permit the forming operations. Its approximate composition is given as 55% Co, minimum; 33% Cr, maximum; and 6% W, maximum. The greater malleability of the nickel-base Hastelloy C was required in the smallest-size reflector.

Fabricating and Polishing Operations

The casting operations are performed at the Haynes Stellite Co. plant at Kokomo, Ind. Slabs are cast about 2 ft. sq. and about 1 in. thick, and are hot-rolled to sheets of about 3/16 in. in thickness by Ingersoll Steel & Disc Co., Newcastle, Ind. Because of the high-temperature hardness of the Stellite, it is necessary to heat the material to 2100 F. to make it sufficiently plastic for rolling. At this temperature only slightly under the melting point of 2327 F., the metal can be rolled out in reductions of about 0.025 in. per pass. It must be reheated after each pass to maintain the high temperature.

Discs are blanked from the sheets and pressed to approximately parabolic form at Struthers-Wells Co., Warren, Pa. Blanking and forming are done hot, the temperature here being in the same range as for rolling. Hard-faced rolls and dies are used in these operations.

The finished reflectors are handled carefully to avoid any possibility of marring the finish.

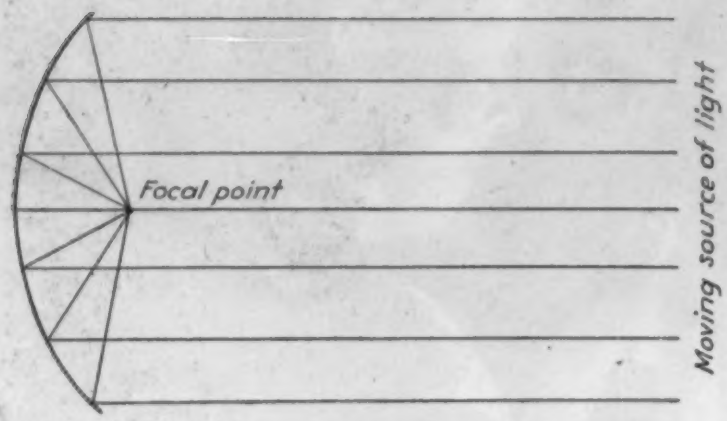
Finishing operations are performed at Bausch & Lomb Co., Rochester; Baker and Co., Newark, N. J., and Chrysler Corp., Detroit. The last named uses a modification of its superfinishing process, using equipment designed especially for this project. The blanks are first machined in a Lehman lathe, which cuts off scale, shapes them and cuts them to the correct diameter. A small dimple is machined in the exact center of the disc to aid in locating the arc in the finished searchlight. Another lathe then takes the finish cuts over the face of the reflector, and gives it the desired parabolic form. Carboloy tools and a specially developed coolant are used in the machining operations. The parabolic form must be maintained with a high degree of accuracy, since tests upon the finished piece require curvatures correct to 0.0002 in. A grinding operation follows turning in the lathe.

The Chrysler Corp.'s superfinishing process, used on their 24-in. reflectors, makes use of an adaptation of the conventional superfinishing machine. The process has been so completely mechanized that unskilled labor can be used almost entirely. About 80% of the employees in this division are women.

Following the treatment with fine stones and light pressures in the superfinishing machines a further polishing treatment is given, using a loose abrasive. This abrasive is a very fine optical polishing material. The reflectors leave the machine with a mirror finish which has not yet been reduced to a measurable basis. The surface has zero microinches average roughness under a testing machine.

Since the beam from the 24-in. searchlight is given a range of 23 miles, high reflectance and small divergence are essentials of the reflector. The required reflectance is 68 to 70%, with divergence not exceeding ¼ in. from the nominal size at 20 ft. All inspection upon the reflectors is done by light-measuring or photographic means.

The focal length is accurately determined and the accuracy of parabolic form is tested by a beam of light.



The contour of the reflecting surface is checked by this white board ruled in squares. Any waviness of the lines indicates an inaccuracy of the contour of the reflecting surface.

Inspection Methods

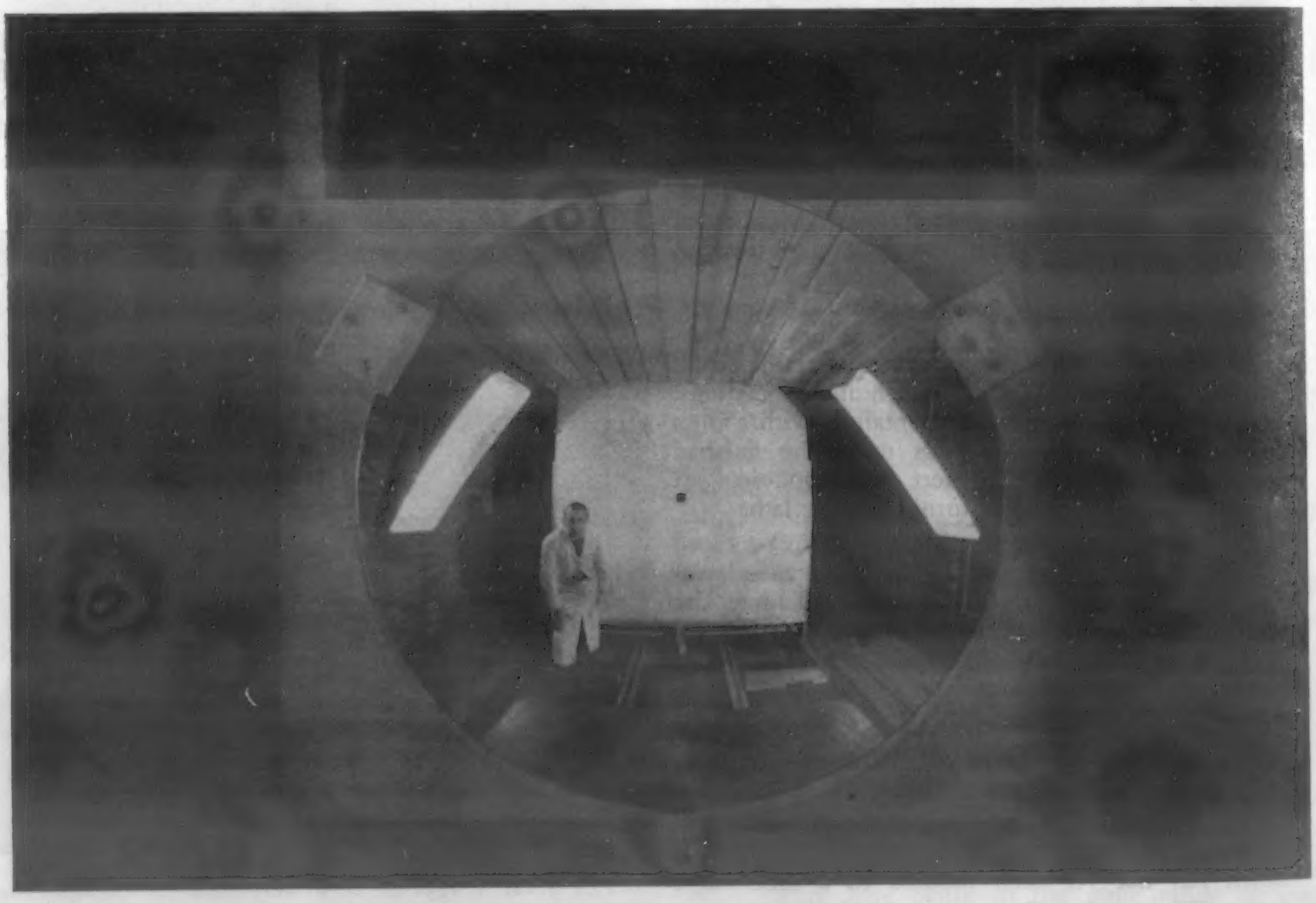
Testing for accuracy of the entire disc is done by placing the reflector before a large board painted white and ruled into 1-in. squares, and photographing the reflection of the board in the parabolic reflector. The pictures take in about 92 sq. in. of the ruled surface. Any waviness of the rulings indicates an inaccuracy in the contour of the reflector surface. Determinations to 0.0002 in. are possible by this method.

Accuracy of parabolic form is determined by a collimation test. This also fixes the divergence of the beams from the searchlight. A photographic plate is placed at the focal point, 9¾ in. from the reflector, and a source of light essentially a point is moved in a straight line vertically before the reflector so that it is reflected onto the photographic plate as shown. The point on the plate which represents the collimation of all the rays is required to be not more than ⅛ in. across. This plate becomes a part of the permanent record of inspection of each individual reflector. The exact focal length of the reflector is determined at this time, and marked on the piece.

In packing and shipping, great care is taken to preserve the reflector surface. The piece is placed in a waterproof bag, and the whole placed in a specially designed cardboard carton. The cartons are packed in wooden boxes, two to the box, and wedged tightly in place to prevent movement in any direction.

While the reflectivity of Stellite is only about 68 to 70% throughout the visible spectrum, it has the great advantage of maintaining this reflectivity under service conditions. The reflectivity of silver is much higher — about 95% — but that metal tarnishes more readily and, because of its softness, scratches more easily if repolished.

While many details of the procedure and of the exact nature of some of the materials used are regarded as secret, the information so far released indicates a step forward in the working of hard materials which will be adaptable to peacetime production.



The focal point is determined by moving a light vertically in front of the reflector. This also serves to check the trueness of the contour.

Basic Refractories for the Copper Industry

Part I

Much progress has been made during the last 15 years in the application of basic brick to increase the production or improve the economy of copper smelting and refining furnaces. In certain types of furnaces, indeed, basic brick have completely replaced silica brick in the construction and maintenance of critical portions. This article describes the development and progressively increasing use of basic refractories for copper reverberatory furnaces, converters, refining and secondary metal furnaces, with details of the comparative performance of various types of brick and recommendations as to best design and construction for maximum brick life. This first instalment covers the reverberatory furnace phase of the subject. —*The Editors*

by **R. P. HEUER AND A. E. FITZGERALD**

General Refractories Co., Philadelphia

THE TREND OF DEVELOPMENTS in refractories for the copper industry has emphasized three major objectives: To withstand more severe service conditions, to increase the operating rate of the furnaces, and to give longer life and less idle furnace time for repairs and rebuilding.

An idle furnace is an expensive furnace. A modern furnace represents a large capital investment and if idle because its production is not needed, it is an expense. If idle when production is needed, it is a still greater expense. These considerations make it imperative that the number of furnaces be kept to a minimum and the productivity of those available be kept at a maximum. Thus it is important that the refractories used in furnace construction give long life under high operating rates and severe service conditions.

Basic Brick Types and Uses

The first major development in this direction was the substitution of a basic refractory such as magnesite for an acid refractory such as fireclay or silica brick. The basic lined converter was an early example. The use of magnesite brick in furnace sidewalls in place of fireclay or silica brick was another. Suydam[1] has reported developments as of about 15 yrs. ago. Since that time there have been extensive developments in basic refractories. New types of basic refractories have been developed. Some of these have been sufficiently superior in properties to warrant very extensive use. Furnace operation has been improved by increasing production and eliminating idle time and costs have been reduced.

The only basic brick initially available to the copper industry was burned magnesite brick. This brick, as its name implies, consists mainly of magnesia and is bonded by firing in kilns at high temperatures. Typical raw materials comprise naturally occurring magnesium carbonate or magnesium hydrate or the artificially prepared hydrates obtained by processing dolomite or seawater. These magnesia compounds are dead burned by firing to high temperatures, driving off volatile materials and producing a calcine having 80% or more of magnesia. This dead burned magnesite is crushed, ground and screened to pre-determine particle size and molded into the desired shape. After drying, the shapes are fired to high temperature in kilns to produce a hard, strong product.

A radical departure from this procedure was the development of the "Ritex Process" and its full scale introduction in 1928. The first product of this process was an unburned magnesite brick as described by Fitzgerald[2]. The new process was characterized by the following features: The selection of particle sizes for the brick mix using the principle of "gap grain-sizing" to obtain the best interfitting of the grains, the formation of the brick under very high pressure to thoroughly consolidate the sized particles and produce dense brick, the bonding of the formed brick without kiln firing by the use of chemical bonding agents.

This new product gave longer life than burned magnesite brick because it spalled less. Fortunately its selling price was also lower. As a result, it not only displaced burned magnesite for many uses, but permitted further elimination of silica and fireclay refractories and provided better furnace operation.

The next important development was the manufacture of an improved brick containing principally chromium ore. This work has been described by Seil[3] and Heuer[4]. A mixture of about 75% chromium ore and 25% magnesite was used. The bricks were made available in both the burned and unburned form. When compared with burned magnesite brick the new chrome-magnesite products cost less, had lower thermal expansion and higher resistance to spalling. These advantages encouraged the use of chrome-magnesite in place of magnesite and in the further displacement of silica brick.

Another development in the copper industry was the extensive use of basic brick encased or clad with thin sheet steel on their principal surfaces. Metal-encased basic brick had long been used in steel melting furnaces where improved spalling resistance was required. Their use in certain parts of copper furnaces has proven very advantageous. The steel plates in the joints of the brickwork operate to keep the masonry tight because of the expansion of the steel upon oxidation. Further, the oxidized plates unite with the basic brick forming a tightly bonded monolithic mass in which spalls are more firmly held in place and the rate of spalling is reduced.

In the newest type of brick the steel plating is an integral part of the brick. The plates are applied to the brick by a special method of molding when the brick is formed. Thus the plating is well fitted and permanent. Steel clad brick are of the greatest value where maximum resistance to spalling is required in basic brick.

More recent developments in basic refractories have provided newer types of chrome-magnesite brick in which the content of magnesite has been increased for specific purposes. In some of these brick the finer size particles of chromium are eliminated from the mix and in their place fine magnesite particles are used. The coarser particles of the brick are all chromium ore. The finely grounded magnesite particles completely surround and coat the coarse chromium particles. Such a brick has many of the desirable chemical characteristics of magnesite brick which are often lacking in chrome-magnesite brick. At the same time the desirable physical characteristics of chrome-magnesite brick are retained.

The methods by which these various basic refractories are employed in the copper industry can best be described by considering the various furnace operations in the following groups: Reverberatory smelting furnaces, converters, refining furnaces and secondary melting furnaces.

Reverberatory Smelting Furnaces

There are now in operation on the continent of North America 12 large smelting reverberatory furnaces built entirely of magnesite brick. Of these 12 furnaces to 10 are smelting calcines, 2 are smelting raw concentrates. In addition, there are several other furnaces in which magnesite brick have been substituted for silica in the uptake and front wall so that the only remaining silica brick are those in the roof. Silica brick were used originally in reverberatory furnace roof construction because of their inherent ability to remain volume stable and rigid at high temperature and under heavy pressure. Thus they were ideally suited for the construction of simple sprung arches in the very wide span common to smelting furnaces.

On the other hand, silica brick are acid and are readily attacked and worn away by the basic fluxes developed in the smelting operation. The fluxes are mainly the oxides of iron and copper, although the oxides of calcium and magnesium are occasionally present in sufficient amount to cause real trouble. These fluxes come from the furnace charge and the fuel ash. They make contact with the brickwork in the form of dust developed during charging and smelting. The rate at which the silica brick wear out increases with the amount and basicity of the dusts coming in contact with the brick and the temperature of the brick.

The amount of fluxes coming in contact with the brickwork is a function of the character of the charge, the method of charging, the rate of charging and the amount of fuel fired in the case of a fuel ash carrying a great quantity of flux. If the charge is dry and finely divided, more dust is created than if it is wet and coarse. The greater the amount charged, the greater the dust potential. Over a period of years the charge has become finer with the introduction of new milling methods, the amount charged has increased in the drive for faster production, and the life of silica brick roofs has generally declined.

The silica brick roofs most commonly used are 20 in. thick. When worn out the usual practice is to shut the furnace down, knock in the worn out roof, remove the old brick from the furnace and put on a new roof. This entailed loss of production, labor for cleaning out the furnace, labor and materials for the new construction, cost of fuel to bring the furnace back, and the general expenses and damage to the balance of the furnace incidental to intermittent operation.

As long as this was necessary only once every 300 to 400 days, it did not cause too much concern. However, as operating conditions changed and production rates were increased, the life of a silica brick roof became shorter, and instead of lasting 300 to 400 days, the roof lasted only about 100 days, or even less. Various steps were taken to increase roof life, or at least eliminate the shutdowns. The adoption of wet charging eliminated some of the dust and increased the roof life. Honeyman[5] has described an increase from 90 days to 180 to 270 days.

Wagstaff[6] has described the method of gun feeding calcines and thereby reducing the dust brought in contact with the silica roof. This method of feeding, used under the conditions described, increased the life from 80 to 100 days to approximately 200 days.

Severe Service Reverberatory Refractories

These improvements in roof life have been sufficient to the needs in many cases. However, in at least one instance the operating conditions were such that the roof life, even with wet charging, ultimately got back to 90 to 100 days. Again there was the ever present desire for still longer roof life even in spite of higher operating rates. The use of two silica roofs, one superimposed on the other, making 40 in. thickness in all, increased the life before replacement from 175 to 200 days to 350 days under the conditions tried. This eliminated one shut-down and helped tremendously. However, all these improvements left something to be desired for the severe operation and further approaches to the problem have evolved.

A typical exterior view of a suspended basic roof.

One method has been to continue the use of silica brick as the roof refractory and to supplement it with improved methods of maintenance. The other method recognized the silica brick's inherent inability to resist fluxing at high temperatures and discarded it entirely by substituting magnesite brick in its place. Where the silica brick is retained as the roof refractory, the brick which is worn away is replaced by spraying with a highly siliceous mixture comparable in composition to the original silica brick.

Shutdowns for repairs are avoided by applying the mixture without taking the fuel off the furnace. One such method is described by Winkler, Mooney, Kuzell and Mounts[7]. It is reported that this method of roof maintenance used in combination with gun feeding and a double silica roof kept one furnace in operation for nearly 4 yr.

The roof construction wherein the silica brick is discarded and replaced by magnesite brick is the result of at least 15 yr. of detailed experiment. The progress up to the end of 1938 has been reported by Boggs and Anderson[8], Ambrose[9], Boggs, Anderson and Stevens[10]. The first use of magnesite brick was as shoulders in the smelting zone. These shoulders extended 36 to 48 in. out from the skewback on each side of the furnace and surrounded the charge holes.

At Noranda Mines this use of magnesite brick, when smelting 900 tons per day, increased the roof life from 100 to 140 days, or 40%. At Hudson Bay Mining & Smelting a similar use of magnesite brick increased the life from 60 to 75 days to 95 days, or an average of approximately 40%. In both cases the failure ultimately occurred in the silica brick and the condition of the magnesite brick at the time of the silica brick failure indicated that magnesite brick would last much longer than silica. A trial arch 15 in. thick was built entirely of magnesite and failed in 37 days due to structural weaknesses.

In 1932 the first suspended magnesite arch was installed at Hudson Bay Mining & Smelting Co. The novel features of this roof included the use of unburned magnesite brick and thin steel plates in the joints. As reported, this roof was a success from the start. On the initial run the life was increased from 95 to 386 days and the idea of discarding silica and substituting the chemically bonded magnesite was proven sound and practical.

During the last 10 yr. the suspended magnesite construction has become standard for use not only in the smelting zone but the rest of the roof as well. The furnace design has been simplified and refined. Continuous maintenance has been developed, thereby eliminating shutdowns. Maintenance labor has been reduced to a minimum. Considerably higher smelting rates have been attained and refractory costs have been reduced. Fig. 1 is a typical exterior view of a suspended basic roof.

Fast Smelting at Low Cost

With the use of suspended magnesite roofs very high smelting rates are safely maintained at very low cost. Furnaces on calcine charge are regularly smelting 1400 to 1600 tons of new metal bearing materials per furnace per day. One plant survey as of April, 1943, shows the following: "Since using complete suspended magnesite roofs and smelting at a rate of 1495 tons per day, the amount of brick used is only 1/12 that required for silica brick at a smelting rate of 1220 tons per day. On comparable rate of smelting it is estimated the amount of brick is only 1/16 that which would be required for silica." The actual cost per ton of charge smelted of suspended magnesite roofs has been considerably less than had been the case with silica. One basic roof has been operating since 1940 with no shutdown for roof repairs.

While absolutely comparative data are lacking for suspended magnesite roofs versus continuously maintained sprung silica roofs for all type operations, a few observations can be made on the experience to date. It was thought originally that suspended magnesite roofs would not be economical unless the life of the silica roof was considerably less than 100 days. This would nominally limit the use of the suspended magnesite to smelting zone proper, but this has not been true. The suspended magnesite has displaced the silica even outside the smelting zone where the life in silica was regularly much more than 100 days. In one plant continuous maintenance of a silica roof by spraying was tried, but a subsequent trial of suspended magnesite found the latter preferable. In still another instance suspended magnesite has been found preferable to silica in smelting raw concentrates.

The initial installations of basic roofs were made in the smelting zones of reverberatory furnaces. From this beginning the installations were extended to cover the full furnace roof. In addition, the uptakes and front walls were made of basic refractory. At least 17 furnaces are now operating with basic uptakes and front walls. In some of these furnaces the main arch is still silica brick. Six of these furnaces are smelting wet concentrates, the balance calcines.

Concurrent with the use of basic brick in the roofs, a more extensive use of basic refractories is also being made in sidewalls and crucibles of smelting reverberatories, presumably due to higher smelting rates, higher furnace temperatures and longer campaigns. For this type of work the unburned magnesite brick is the most widely used.

The majority of side charged furnaces are now constructed with basic sidewalls. Some furnaces are still constructed with silica sidewalls but this type of construction is largely confined to those furnaces which run at moderate smelting rates where the temperatures and slagging conditions are not too severe. In those furnaces where side charging is not used silica brick are sometimes retained at the slag line and upper sidewalls. In such cases it is necessary to protect the brick at the slag line with external water cooling in order to maintain good operation.

(To be continued)

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FABRICATING AND FINISHING

The New M-1 Soldier's Helmet

—A Pictorial Description

VETERANS WHO SWEATED and cursed in the trenches of the last war have nothing but praise for something *they* never had — the Army's new M-1 soldier's helmet, now standard personal combat headgear for all Uncle Sam's fighting men. The old-timers remember with a shudder two things about the brimmed steel hemispheres they wore into the battles of 1917-1918 — their often devastating inability to remain in a neat, comfortable or non-obstructive position atop the head for more than a few minutes without strangling the wearer, and the complete lack of protection they afforded against shrapnel or bullets striking the head, jaw or neck below the level of one's ears. The modern American military helmet is a tremendous improvement in both these respects.

The new helmet, in the first place is designed to cover the head entirely, except for the face, and in addition to protect much of the neck (especially the highly vulnerable base of the skull). Also, its size and shape are such that it readily fits any head and without constant shifting. The helmets are now made in two parts — a plastic inside component, light, durable and sufficiently protective for behind-the-lines wear, and an outer Hadfield manganese steel helmet that is conveniently slipped over the plastic liner when entering a combat zone.

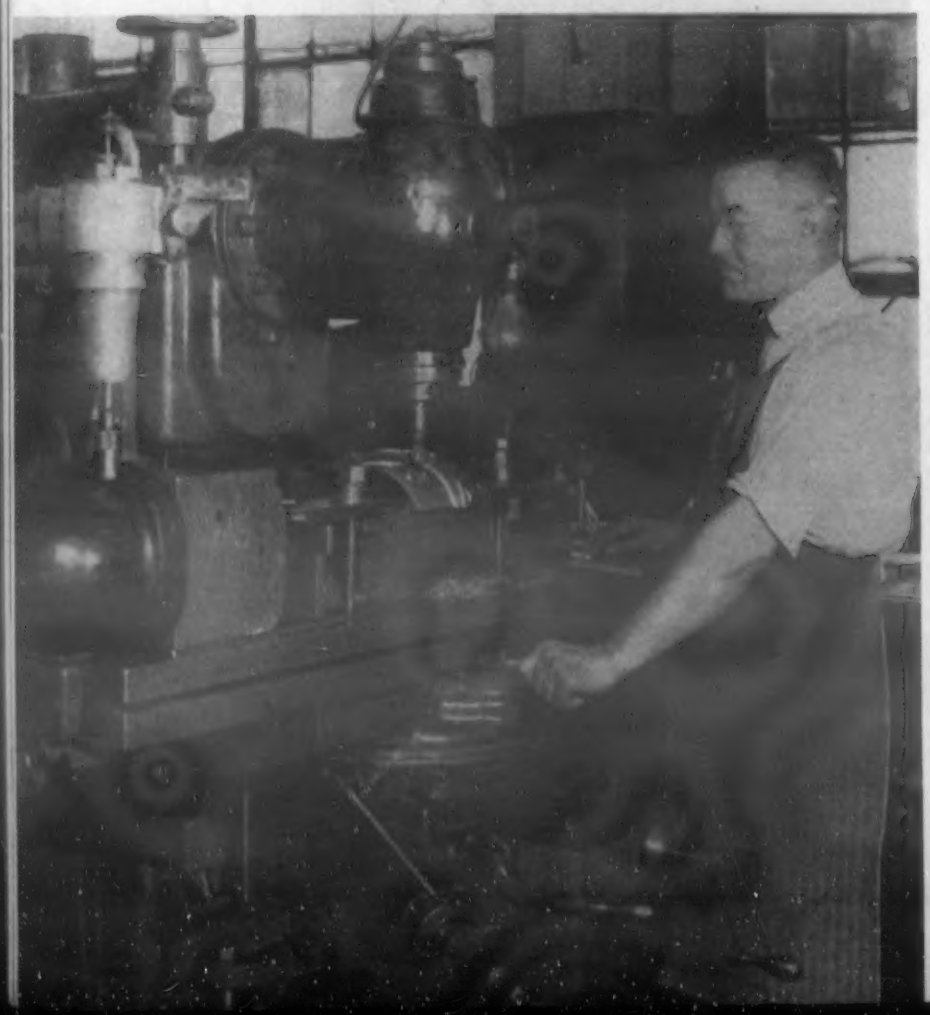
Many engineering problems had to be solved in developing and manufacturing the new steel helmet. The draw of course is deeper than in preceding models and the steel work-hardens exceedingly fast. Welding, cleaning, painting, cork impregnation and inspection operations also had to be set up. The pictures that follow give some idea of these and other steps in the manufacture and assembly of the new helmet.

—H. A. K.

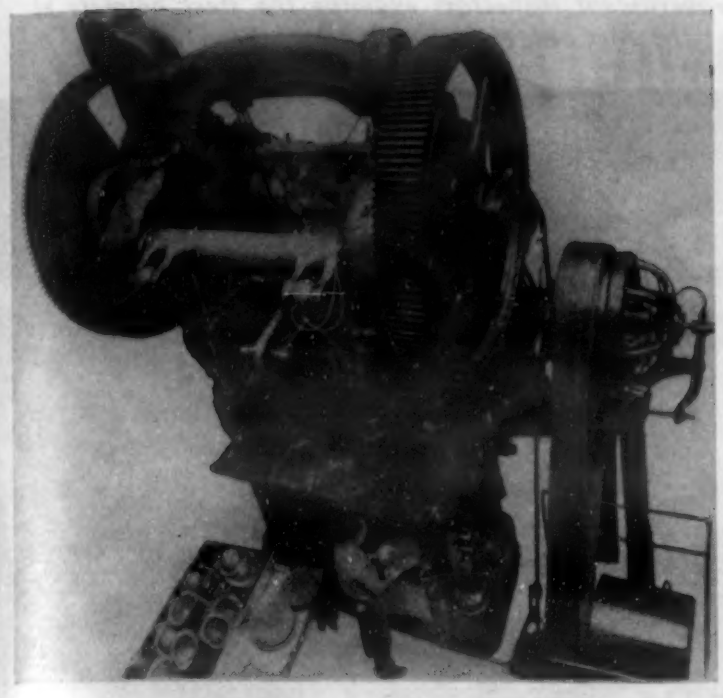
Our story properly starts at — of all places — New York's Metropolitan Museum of Art, in whose workshop the Army found the personnel, knowledge of armoring, tools and inspiration needed to develop new personal armor such as a helmet. Ancient armorers' tools are shown here in use shaping patterns in soft Swedish iron at the museum. The same anvils, bellying hammers, planishing hammers, drawing hammers, shears and mallets that were used hundreds of years ago give the desired shape. At the right is Stephen Grancsay, curator of arms and armor for the museum and technical consultant in the Ordnance Dept. (Wide World photo)

Leonard Heinrich, armorer of the Metropolitan Museum of Art, trims the bowl of the pattern for the helmet with a modern pattern shears. (Wide World photo)

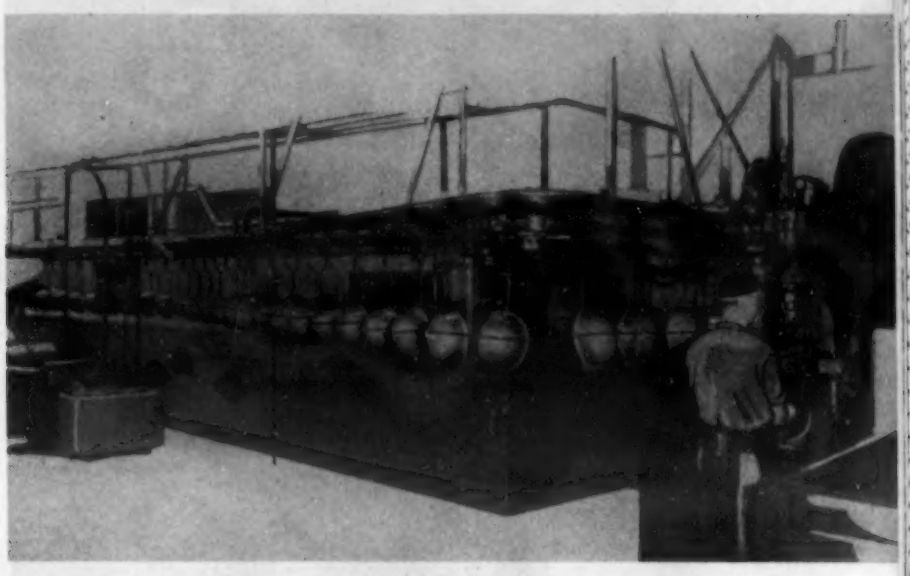
The scene now shifts to the McCord Radiator & Mfg. Co., Detroit, who produce the helmets. Before the helmets can be formed from sheet metal, dies and punches must be designed and manufactured. This machine mills a section of the punch that later forms the helmet to shape in a drawing press.



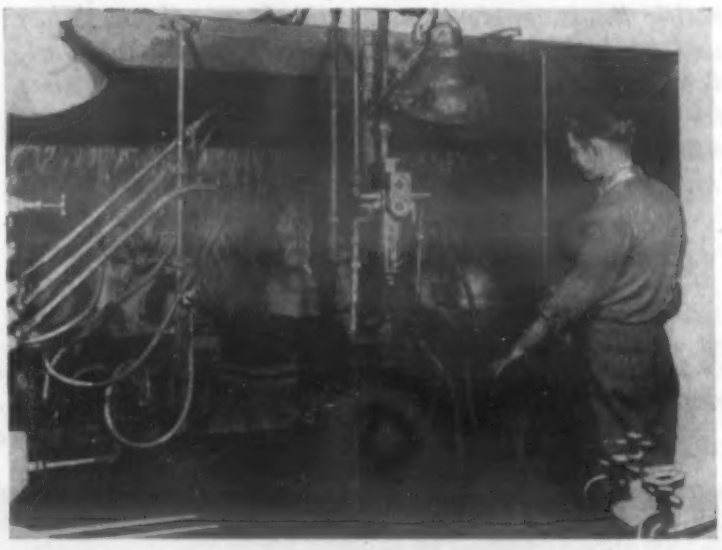
Grinding and polishing of the die, hold-down ring and punch, used for forming the M-1 helmet are important preliminary operations.



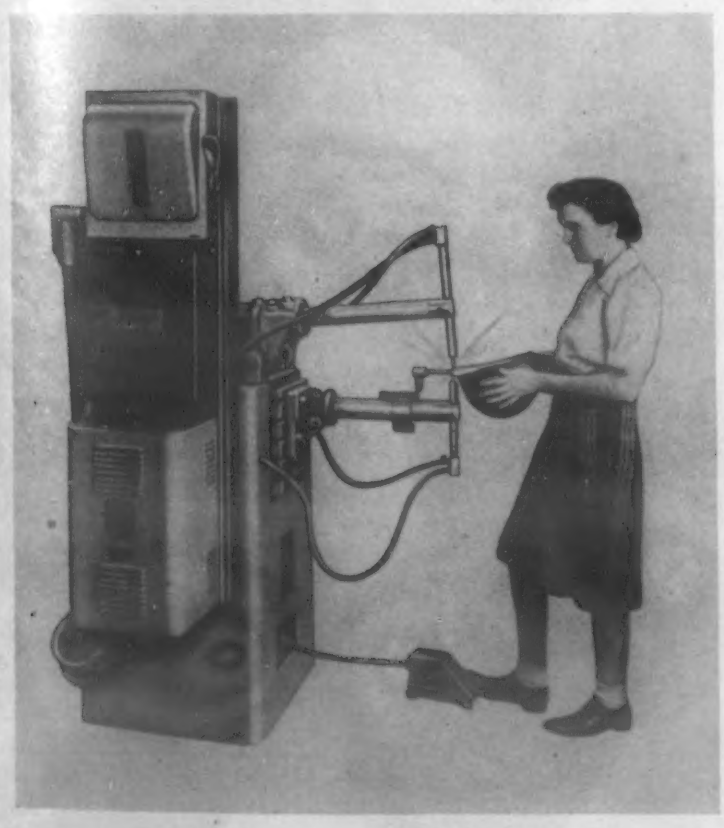
For the actual fabricating stage, round flat sheets of Hadfield manganese steel arrive from the steel mill and are placed under a giant press, two at a time, the complete forming being accomplished in one draw, under the high-carbon cobalt steel dies. A large punch works through a hold-down ring into a die. Irregular edges are trimmed off by a smaller press.



The drawn and trimmed helmets travel on a conveyor through a spray washer while pieces of edging are simultaneously made from stainless steel strips in a forming machine.

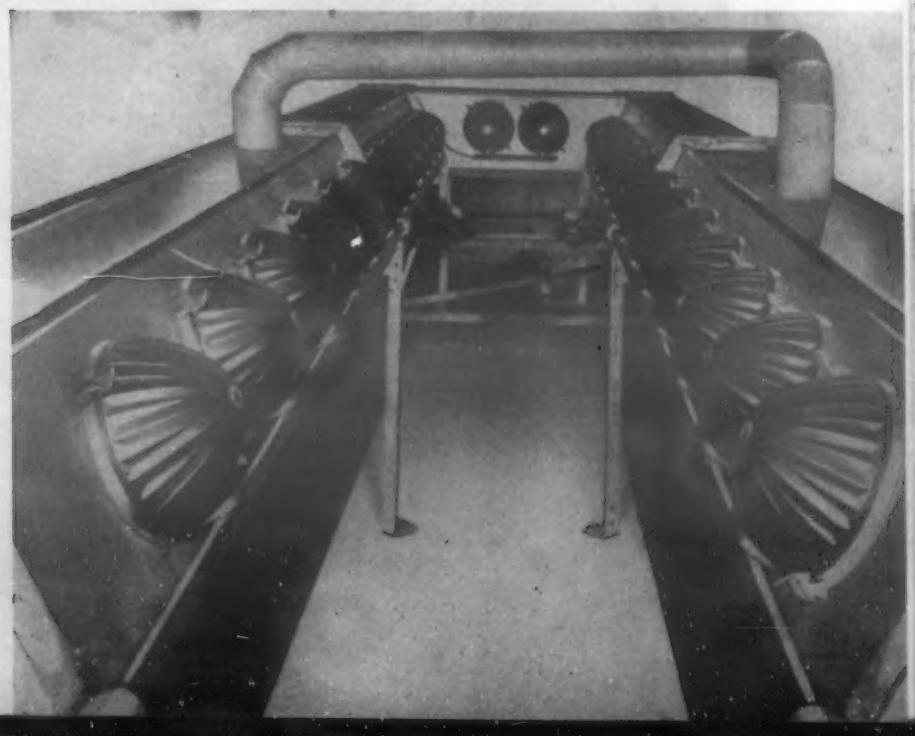


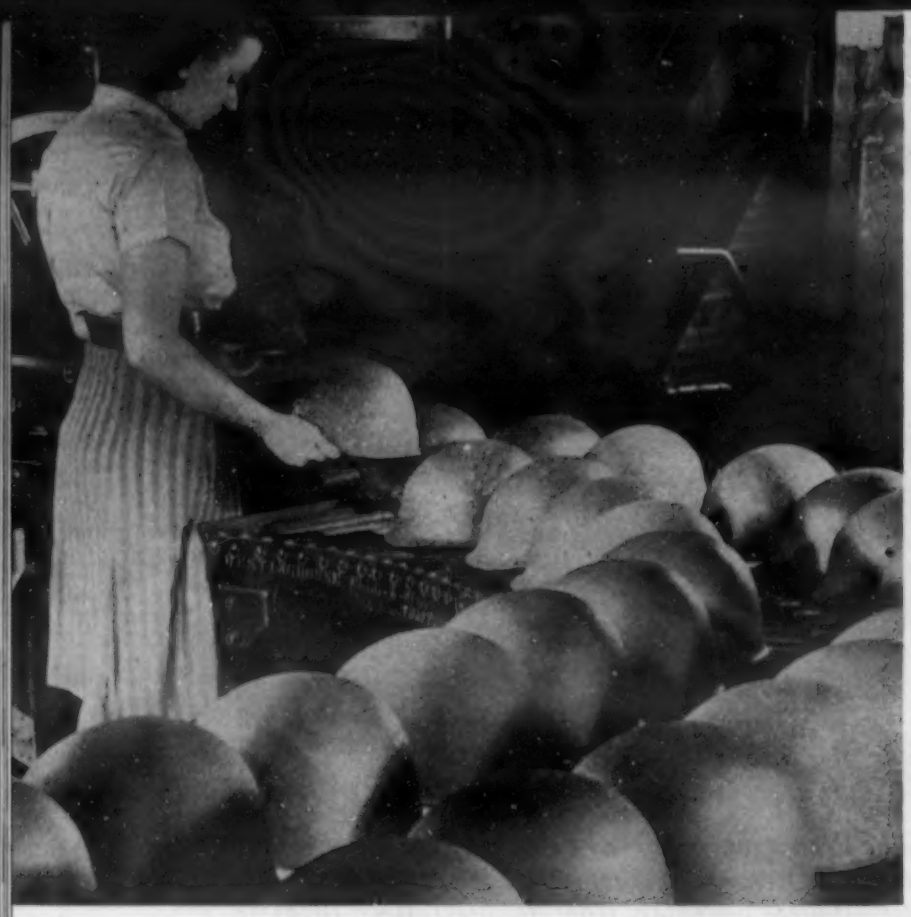
The stainless steel edging, cut to proper length, is spot welded to the edge of the helmet, as are two lugs for chin strap attachments. A conveyor then carries the helmets through a phosphoric acid-alcohol cleaning bath and rinse to prepare for painting. Specimens of the finished steel parts of the helmet are micrographically inspected in the laboratory.



Conveyors carry the helmets past synchronized paint spray nozzles and the helmets revolve so that the olive drab pigment will cover them uniformly. The paint for the exterior is mixed with cork particles for resisting light glare and dulling metallic sounds when in service.

The paint is dried under 73 infra-red lamps as the conveyor carries the helmets through an oven. After this operation the chin straps, made of a fabric belting material, are stitched on with sewing machines.





Look closely — but still you wouldn't be able to tell that these helmets are plastic — actually the plastic liners, made at a Westinghouse plant. They are the inside halves of the Army's new two-part, double-purpose helmet. Made of tough plastic, they are comfortable and sufficient for behind-the-lines wear. The outer steel shell is slipped on for front-line combat. Here the plastic halves are being given final inspection. (Wide World photo)

Government inspectors examine the steel helmets at the McCord plant. (Associated Press photo)

Ready for action! Assembled pieces are lined at the Long Island plant of I. Miller & Sons, Inc. or at the plant of the Hawley Products Co., St. Charles, Ill. At this point they fit any head and are able to turn aside a 45 cal. bullet of a pistol fired at 20 yards. (Wide World photo)

Stress Corrosion of Cast Irons

By R. F. HEHEMANN, D. A. SHEPARD and L. THOMASSEN

Dept. of Chemical and Metallurgical Engineering, Univ. of Michigan, Ann Arbor, Mich.

Although gray cast irons and austenitic cast irons are widely used in chemical plant equipment for handling hot concentrated caustic solutions, virtually no data have been published on their resistance to stress corrosion that might assist the equipment designer or materials engineer in appraising their suitabilities. Such data are now offered in this article, which reveals, among other things, that malleable iron castings possess unexpectedly good resistance to stress corrosion. —*The Editors.*

THE EFFECT OF STRESS CORROSION on boiler steels, as revealed by intercrystalline cracking, has been extensively investigated by Straub,[1] Schroeder and Berk,[2,3,4] and many others. In general these investigators found that the failures were caused by hot concentrated caustic solutions acting on highly stressed steel. It is generally believed that stresses above the yield point, that is, in the range of plastic deformations, are required to produce stress corrosion failures. Similar failures of stainless steel have been reported by Hoyt and Scheil[5] and by Hodge and Miller[6].

A review of the literature failed to disclose any data on the susceptibility of austenitic cast irons and gray cast irons to stress corrosion phenomena, although such materials are used extensively in modern process industries equipment for handling hot concentrated caustic solutions. It is an objective of the present investigation to determine the stress corrosion characteristics of cast irons with special emphasis on the effects of strain in both the elastic and plastic regions. A flexure test was chosen because it is this type of failure that generally occurs under service conditions.

The Apparatus

Fig. 1 shows a sectional view of the apparatus. The cantilever test specimen (A) in this illustration has a critical section of approximately ½ in. sq., and it is arranged to receive an autoclave. The specimen is stressed by tightening the set screw at the left (B) thus applying tension to the weigh-bar wire (C). The applied load is read from the Ames dial gage (D), each 0.001 in. extension of the weigh-bar wire is equivalent to 8⅓ lbs. The method of stressing the specimen is such as to give immediate indication of the effects of stress corrosion by relaxation of the load.

The autoclave (E) was made of Monel metal to resist corrosion from the caustic solutions. A small amount of white lead was applied to the male threads on the end caps of the autoclave to prevent seizing of the threads when assembling. Care was exercised that none of the white lead got into the chamber since this would have acted as an accelerator in the stress corrosion tests, as shown by Schroeder and Berk.[2]

A furnace was placed around the autoclave. The temperature was controlled by a thermocouple in the winding of the furnace. A controller of the Hoskins type with a separate relay attachment was used with suitable resistances to maintain the temperature inside the autoclave at 270 deg. F. ± 5 deg.

The relaxation curves for tests of short duration were determined very closely, but the time of final failure for tests of long duration was determined by stopping a clock. The moving arm of the Ames indicator closed an electrical circuit when the load had relaxed to a dial reading of 0.001 in. This operated a magnetic relay by means of a battery thus opening the 110-volt circuit and stopping the clock.

Materials

Tests were made on an austenitic cast iron having a tensile strength of 29,400 lbs. per sq. in. and a nominal analysis of 1.5 Cr and 18 per cent Ni; an A.S.T.M. specification A48-36 class No. 25 gray cast iron; and an A.S.T.M. Specification A47-33 grade 35018 air furnace malleable iron. The test bars were cast vertically in dry sand molds and showed normal microstructures. The critical section of the test bar is at a moment arm of 7 in. from the point of application of the load. The critical section of the test bar was not machine finished since it was decided to simulate service conditions.

All tests were run with a 50 per cent solution of sodium hydroxide (NaOH) at a temperature of 270 deg. F. With few exceptions the specimens were pre-stressed to determine the tensile strain. The autoclave was then placed on the test specimen and stress corrosion conditions established.

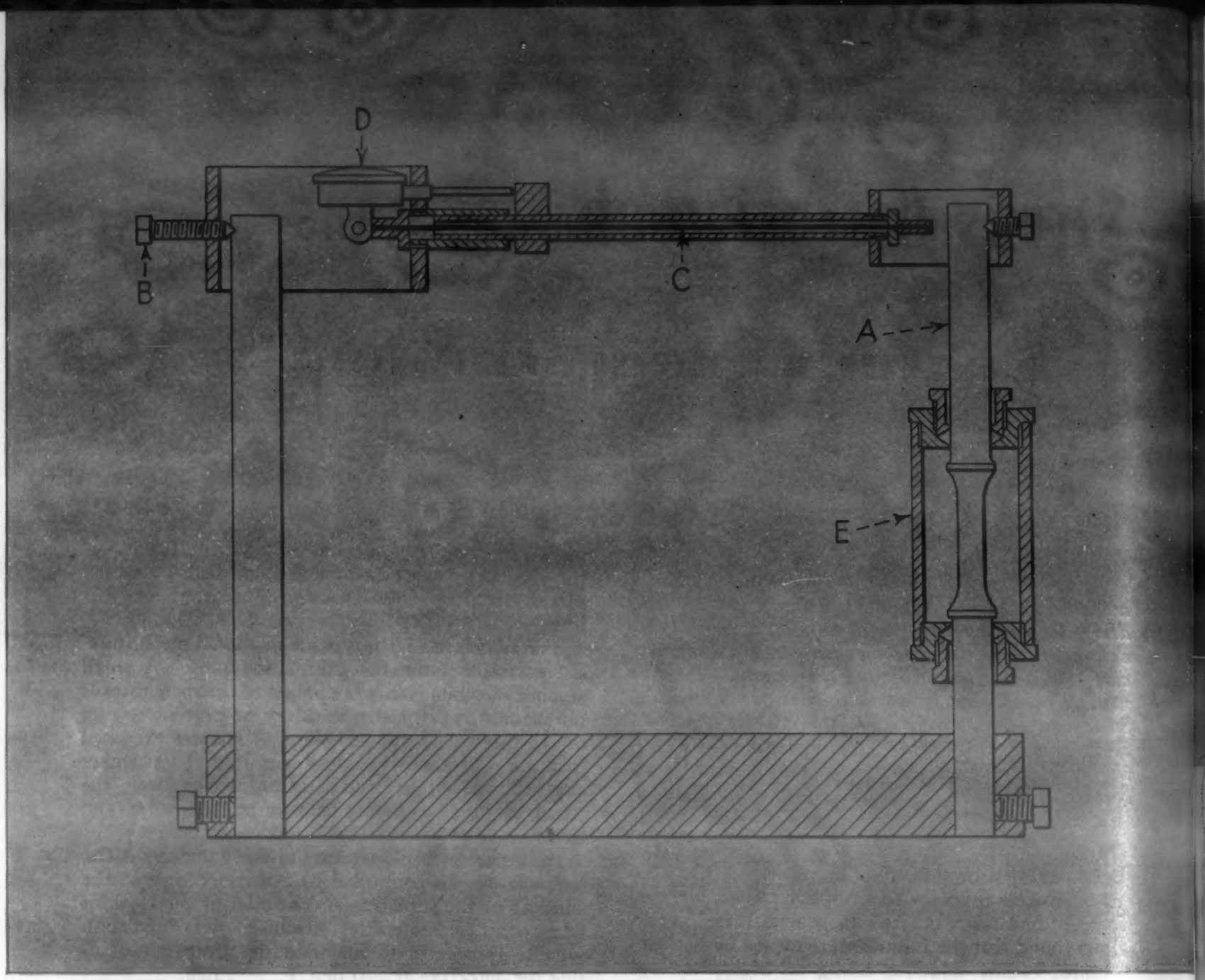


Fig. 1. The stress corrosion device or apparatus.

Results

The stress corrosion test results are shown in the table. The transverse stresses given in this table are based on the beam formula. Values thus determined do not represent true stresses and are given for purposes of comparison only. The tensile strains shown were determined by plotting the strains observed in a separate test piece against the transverse stresses for a 6.5-in. moment arm, the distance from the point of load application to the mid point of the extensometer gage length. The strain at the 7-in. moment arm, the critical section, is then read from the transverse stress for this moment arm, see Fig. 2. The tensile stresses given in the table were determined by reading the stresses from the tensile stress-strain curve of Fig. 2, at tensile strains corresponding to values determined in the transverse tests.

A log-log plot of stress against time to fracture for the austenitic cast iron is presented in Fig. 3. The upper curve represents the stresses as calculated from the beam formula, the lower curve represents tensile stresses as determined above. Fig. 4 shows a photomacrograph of a broken test specimen. Fig. 5 to 7 show photomicrographs of the austenitic iron after corrosion has taken place.

Engineering Significance of the Results

The elastic properties of the materials were determined as the preliminary tests since stresses exceeding the yield point generally are considered a necessary condition in caustic embrittlement failures.[1, 7] In a flexure test however only the outer surface is highly stressed. The yielding of the surface layer is masked by the load carrying capacity of the underlying material which is still within the elastic range of strain.[8]

The effect of this apparent change in yield point may be seen from the results of test No. 8 of the Table. Test No. 8 on austenitic cast iron was conducted at a transverse stress of 14,650 lbs. per sq. in. and failed in 194.1 hrs. The flexure test curve shown in Fig. 2 shows very little plastic strain at this stress. However, the tensile test curve indicates that a small amount of plastic strain has actually taken place. Figs. 6 to 8 show photomicrographs of the sample from test No. 8. In Fig. 6, the microstructure is not very much changed from the original structure. A fracture has started as shown by the arrows and is composed of a family of interlocking cracks. It can be seen that these cracks follow the graphite flakes and the carbides. These conditions are brought out in

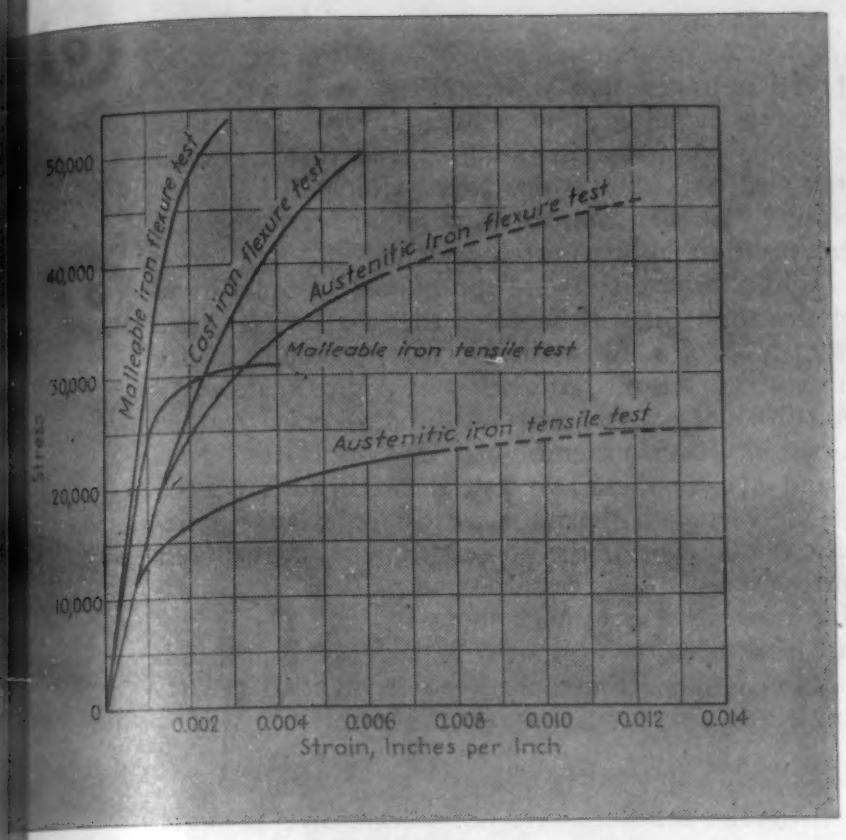


Fig. 2. Correlation of flexure and tensile tests.

Figs. 7 and 8. Although it was impossible to develop an etching technique that would reveal the grain boundaries, the numerous small cracks of Fig. 7, indicate that an intergranular attack had taken place.

Another important consideration in stress corrosion problems is the effect of prior working. The effect of pre-stressing on austenitic iron may be seen from tests Nos. 1 and 3. Test No. 1, pre-stressed to 44,850 lbs. per sq. in., heated for 5 hrs. with no active load applied, failed in one minute upon the reapplication of this stress; whereas, test No. 3, which was heated for 5 hrs. in the unstressed condition, required 52 min. to fail when stressed to 41,000 lbs. per sq. in.

Fig. 3 is a log-log plot of stress against time to fracture for austenitic cast iron. The upper curve shows the transverse stress as determined by the beam formula and the lower curve shows the tensile stress in the outer fiber. The break in the curves at the 12-hr. period would indicate that there was an increase in corrosion rate for tests of longer duration.

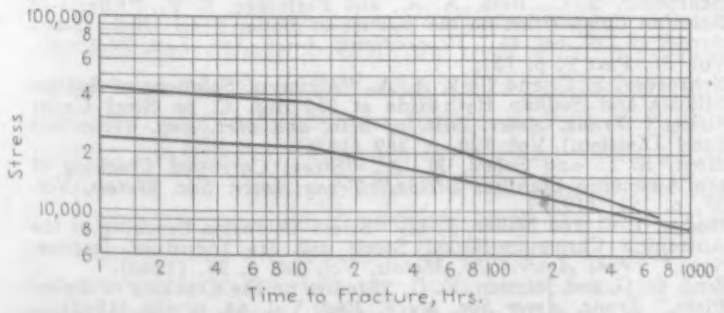


Fig. 3. Stress corrosion tests on austenitic cast irons.

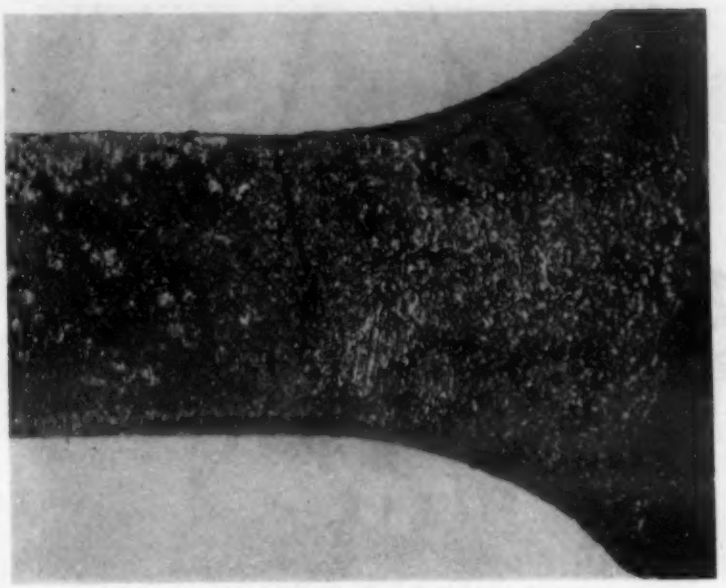


Fig. 4. Failure produced in test No. 2.

Fig. 5. Fracture of test No. 8 showing the fracture following the graphite flakes and carbides with numerous incipient cracks. Electrolytically etched. 100X.

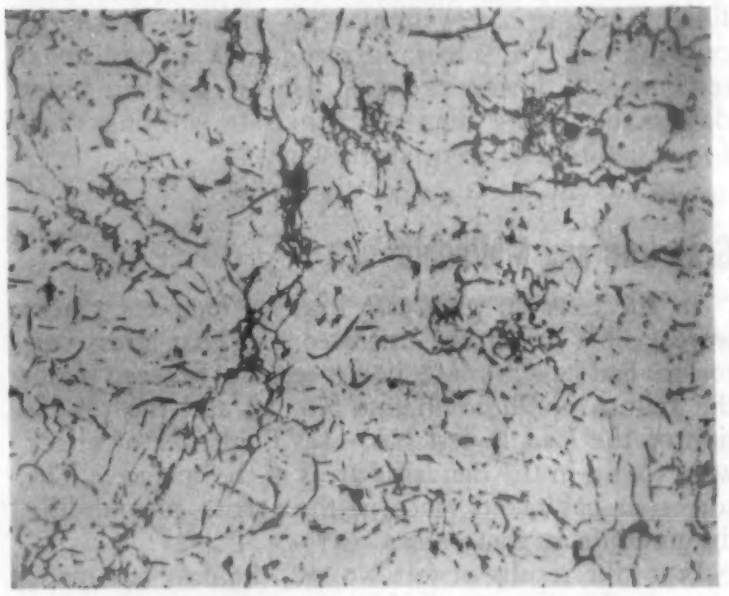
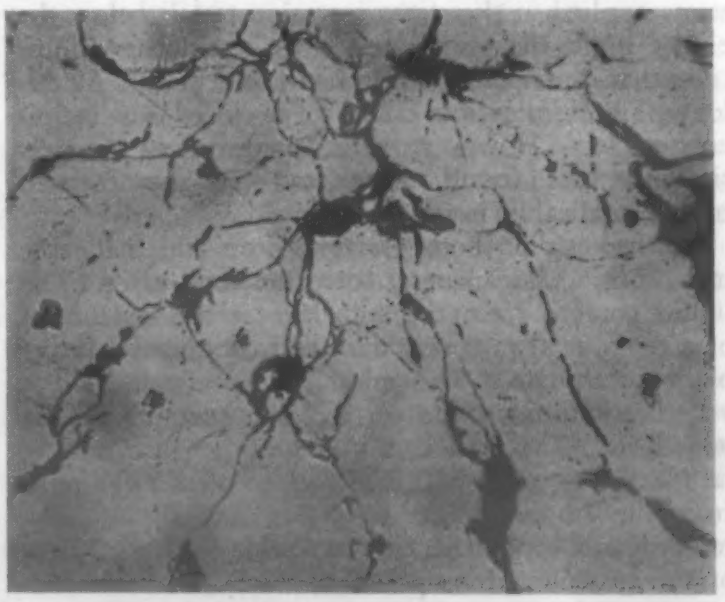


Fig. 6. Test No. 8 showing the many incipient cracks present. Unetched. 500X.



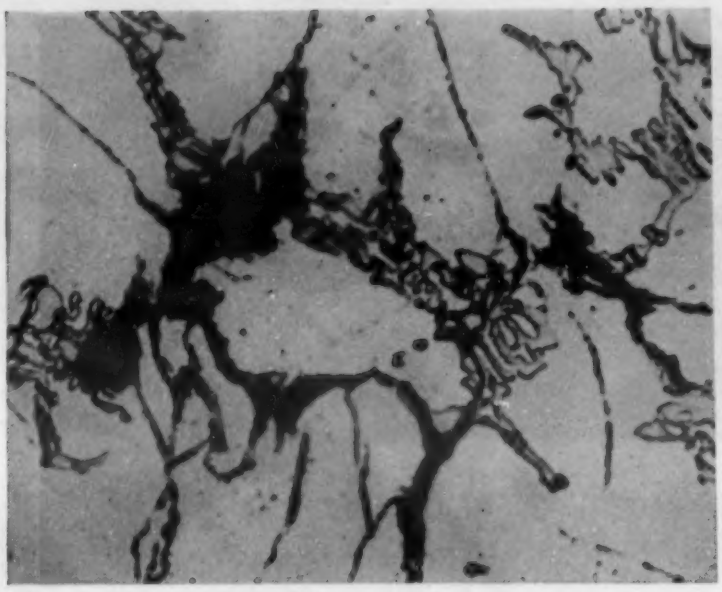


Fig. 7. Test No. 8 showing the attack on the carbides. Electrolytically etched. 1000X.

Another break, causing a decrease in corrosion rate, may be anticipated at stresses below the true elastic limit. Unfortunately limitations in time precluded carrying test No. 9 to failure and running additional tests at still lower stresses. Unless another break does occur, Fig. 4 shows that the safe working stress for austenitic cast iron is very low.

Gray Iron and Malleable

In the tests on gray cast iron no incipient cracks were visible under the microscope. That stress corrosion had taken place however may be seen from the failure produced in test No. 10 and the relaxation of the load in test No. 11. Evidences of attack were found in the dendritic areas at the surface. The corrosion has taken place in the ferrite surrounding the graphite in these areas.

From the results of test No. 12, the only test made on malleable iron, it would appear that this iron was entirely free from stress corrosion at this stress because no relaxation of load occurred. While the flexure test stress-strain curve, Fig. 2, shows that the stress applied in the stress corrosion test is below the elastic limit, the tensile test stress-strain curve indicates that some plastic strain had taken place. Metallographic examination failed to disclosed any incipient cracks. However, surface corrosion products similar to those found on gray iron were also observed on the malleable iron specimen.

In the tests on both gray cast iron and malleable iron, considerable general corrosion took place. The liquid coming from the autoclave at the conclusion of a test was always very dark and contained a heavy black precipitate. The gray iron specimens had a very black film on the surface which could not be wiped off. The malleable iron specimen had a similar black film which was easily wiped off. The liquid from the austenitic iron tests was only slightly discolored and contained no precipitate. The surfaces of the austenitic iron specimens were not discolored.

Comparing the three classes of materials at a transverse stress of approximately 40,000 lbs. per sq. in., it will be noted that austenitic cast iron, tests Nos. 3 and 4, failed in 1 to 3 hrs.; that gray cast iron, test No. 10, failed in 4.3 hrs.; and that malleable iron, test No. 12, was unaffected after 330.5 hrs. exposure. In this comparison austenitic cast iron and gray iron are approximately equal.

While the stresses were approximately equal in all of these tests, it will be noted that the strains varied from 0.0016 in. for malleable iron to 0.0085 in. for austenitic cast iron. At a stress of approximately 23,000 lbs. per sq. in., gray cast iron shows a marked superiority over austenitic cast iron, as in tests Nos. 7 and 11. In these two tests the strains are equal.

Oddly enough the more corrosion resistant austenitic cast iron made the poorest showing in the stress corrosion test. Gray cast iron and particularly malleable iron were very much more resistant to the embrittlement attack, as shown in the Table, although these materials are not nearly so resistant to general corrosion.

Conclusions

Although the tests were not as extensive as might be desired, nevertheless, several conclusions seem to be justified:

(1) The ductility of the austenitic cast iron, a desirable characteristic under normal service conditions, cannot be utilized under stress corrosion conditions. Austenitic cast iron must be considered as a brittle material in design work for applications under stress corrosion conditions.

(2) Under stress corrosion conditions a single application of overstress will materially shorten the life of equipment.

(3) There are strong indications that, even under very low stresses, failures may be expected. This refers not only to the general state of stress, but also to points of stress concentration. Under stress corrosion conditions greater care in minimizing stress concentrations is of prime importance, since the ductility of the material cannot be relied upon to redistribute the stresses.

(4) Where contamination of chemicals by corrosion products of gray cast iron and malleable iron are not objectionable, these materials offer greater freedom from cracking.

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In the dim and wasteful past men worked with their muscles. Modern methods engineering provides power hammers to do the job faster and better.

Methods Engineering in the Metal Industries

by EDWIN LAIRD CADY

Just as conversion to war production required the application of modern knowledge of rapid retooling and the selection of metal-working processes that saved time, materials and manpower, so also will the control of methods profoundly influence the speed and efficiency of reconversion in the transition and post-war periods. This is "methods engineering" and in this article Mr. Cady describes some noteworthy examples of its applications in the metal industries in recent months. —*The Editors.*

BACK IN THE PEACEFUL DAYS of 1938 a group of sales engineers sat about a table. They represented makers of ball bearings, die castings, drop forgings, conveyor belts and machine tools. They were talking about the problems which an automobile company would have in trying to change a car model in only two years of retooling instead of the usual two and one half. And they were agreeing that methods engineering, as practiced by Ford, Westinghouse, General Electric and a few others, might some day reduce the average "change over time" of big factories to only one and one-half years.

Late in 1943 the Bullard Company changed over from machine tool making to the drastically different production of naval engines in a matter of weeks; Pullman Standard—peacetime maker of railroad freight and passenger cars—converted from army tanks to light field pieces in only one week; United States Rubber switched a factory from artillery making to that of rubber tires in only five days; Pratt & Whitney took a large area of floor space away from that assigned to producing comparatively simple lathes and turned it over to highly complex die sinker making almost without losing a day.

All over the United States factories are converting from one war product to another or to civilian goods production, and are doing it in days as contrasted to the months that would have been needed in the pre-war years. They are able to do this because methods engineering has come into its own.

The Function of Methods Engineering

Methods engineering is a technique of somewhat strange ancestry. It has mass production as its grandfather but its immediate parentage is found in the variations of standard products and the special machines and devices which everybody had to make to keep alive in the late depression. To get out these "specials," tools had to be found or created for non-standard operations without waiting long weeks for tool rooms to evolve them or going to great costs to buy them. The product had to be made at the low cost possible only by sending it down the regular production line instead of creating it in one spot as a designer might build an experimental model, operations to be performed on only a few parts had to be so broken down that unskilled or semi-skilled labor could perform them. Skilled labor, ingenious enough to perform complex operations, was too costly and was not available anyway. Costs had to be worked out so finely that the comptroller became as familiar a figure at engineering conferences as the tool engineer.

Obviously, all this could not be done unless everybody who was to work on the special product or to supply materials for it was permitted to contribute his bit of "know how." Coordinating all these ideas and synthesizing them into methods was the methods engineer. His job was to act as coordinator of a "share-the-thinking" program.

Modern hydraulic press methods perform in two minutes a sheet metal deep-drawing operation which formerly took two hours. (Courtesy: The Hydraulic Press Mfg. Co.)

A recent example of how this functions is that of the casting for an engine. The main problem was that of floor space at the engine plant. Tentative methods proposals called for 20 broaching machines to broach-finish recesses in the castings, and some 40 lathes for rough and finished machining, in addition to the space needed for materials handling, scrap disposal, storage of work in process, and the like.

A methods conference was called. Present were engineers of the foundry, the broaching machine maker, materials handling equipment makers, and the sales agency which handles the desired lathes.

The broaching machine makers first proposed that, with a slightly different alloy in the castings, the broaching might be done with much less removal of stock in the preliminary machining than originally intended. The foundrymen countered that they could make the castings to be broached from the rough with no preliminary machining of the recesses. The objection here was that the recesses in the castings might not be well enough in alignment with the control surfaces in reference to which the broaching had to be accurate.

The lathe men suggested that preliminary machining, especially of the control surfaces, be done at the foundry and be followed by checkings of the alignments of the recesses before the castings were shipped. These ideas were combined, with the result that only four broaching machines and a few lathes were needed at the engine plant, the bulk of the scrap was removed at the foundry and nearly all defective castings discovered while still there, thus greatly reducing the scrap disposal cost; and the general floor space and materials handling equipment needs were minimized.

The "Combined Operations" Touch

Methods engineering constantly takes into account the fact that a very small change in one process may have far reaching effects upon others. Thus the foreman of a grinding department, announcing that he had found a new type of wheel which would reduce by 20% the time needed for a surface grinding operation, thought he was merely helping out the personnel department by cutting down the amount of overtime which was leading to absenteeism in his department. But at the next methods conference the foreman of the screw machine room said that if this higher grinding speed could be used to compensate for his working to 0.002 in. coarser limits and thus leaving more stock to be ground off, he could get rid of a bottleneck at his automatics.

The heat-treating supervisor added that this extra stock to allow slightly warped parts to be ground true would cut down on the rejections which were bothering his department. The metallurgical engineer added

that with the heat-treating problems mitigated, a steel of lower alloy might be used, thus eliminating some of the procurement problems. In the end the grinding department foreman found his men working just as long hours as before, but with his faster-cutting wheels resulting in far greater production savings than could be made in his department alone.

Incidents like these have led many a factory to set up a special "methods council," with no change being permitted in methods until the council has reviewed it.

Companies like the wise old Thomas A. Edison Industries carry this principle so far that the testing of many products used along the production lines is not left in the hands of department supervisors. The company knows, for example, that a change in the strength of the solution used in a metal parts cleaning tank might materially increase the speed at which the cleaning is done but have a highly adverse effect in the painting and finishing room. Crews of men under the control of the chemical laboratory and other central departments patrol the plant, make routine tests, and keep all such products within specified limits. The result is to control whole sequences of production as if each were the sole sequence in use in the plant, although many varied sequences may cross each other's paths or may be briefly merged in such departments as the plating room.

One of the principal functions of the methods engineer is to combine operations for greater effectiveness. In the Intertype Corp. plant, when an automatic is to be set up to work on a given size and type of bar stock—say 2-in. round cold rolled steel—the parts inventory of the company is reviewed to find any parts made of that stock which may be approaching their low inventory quantities. Once set up, the machine runs all the 2-in. stock parts that are needed, no matter what the item. The result is a great overall saving in setup time and costs, and in the use of low cost automatic methods for parts runs which otherwise would require hand lathe operations.

Similar to the combining of operations is the finding and listing of secondary purposes for tools. In an automobile body building plant every portable electric and other powered tool is listed for its original purpose which requires highest speeds and accuracies of operation, then for secondary uses in the hands of maintenance gangs or for slower production operations. The result is to make available power tools and methods which never would be had if brand new tools were needed. Great ingenuity is displayed; old electric drills are used to operate temporary hoists as booster motors to get heavily loaded tumbling barrels up to speed, and the like. Naturally this inventiveness is not the property of just one mind; the methods engineer receives requests for the application of power to various tasks, keeps a list of them, makes old portable power tools available along with other discarded motors.

The methods council records are important. Special records are kept of all products tested. In the olden days, if a cutting oil were to be tried, the foreman of the milling machine department might say that he liked it or did not like it, and that would be that. Now a completely detailed record is kept of just how that product behaved; some property it displayed might be vitally important to the working out of a brand new machining sequence.

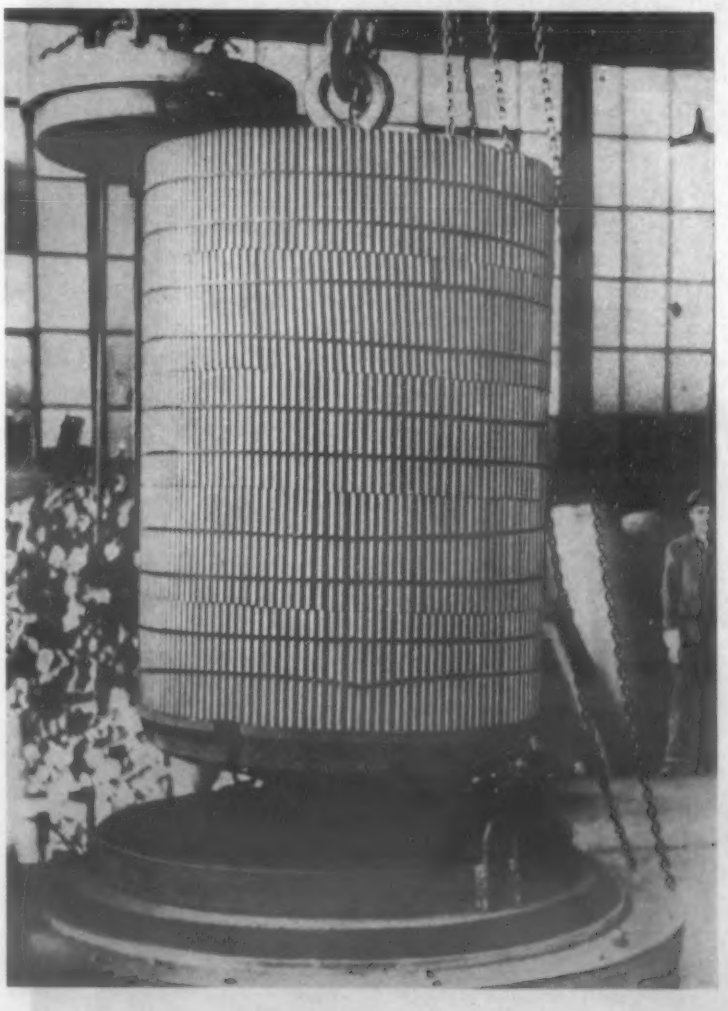
Human Engineering

The methods council has its effect upon human engineering too. With some 100,000 men being given medical discharges from the armed forces every month —many of them crippled or otherwise weakened by the services—this is important.

In one plant, men who have lost an arm, a leg or otherwise are handicapped, are assigned to the personnel department. These men learn the methods engineering scheme of their company from end to end of the plant. Other handicapped men, being interviewed by them, gain confidence. Then jobs are shifted about, special hoists are rigged, push-button control stations are shifted on machines, until a task which the war-crippled man can run is ready for him.

This employment of the war-handicapped is not a charitable nor solely a patriotic gesture. Experience has proved that such men are loyal, steady and hard working. . . . "They see the necessity of a full day of production more clearly than some of their fellows," a plant manager expressed it. Similarly, the X-raying of 1,000 workers in a machine shop disclosed 23 cases of arrested tuberculosis. The methods council studied the records of these men, found them to be among the steadiest and most willing of the entire payroll. The same methods engineering which could make operations involving the handling of heavy weights prac-

Pins stacked for nitriding. The method of loading the furnace saves time in the furnace, boosts production and adds to controlability of the heat treating. (Courtesy: Lindberg Engineering Co.)



tical for women employees, could see to it that these men put their abilities to work without performing any of the hard physical labor that would injure them.

Dermatitis in its various forms was a scourge in the last war. No remedy was found for it, other than to put disinfectants in the cutting oil from which most infections came, and to grant "sick leave" to men badly infected.

In this war dermatitis is far more of a threat, for many machines pump their oil from a single tank and one infected man can spread infection to many others, whereas formerly each machine had its individual sump or tank of oil and the chances of infection spreading from machine to machine were less. But methods engineering turned to the industrial physician for help. He in turn went to the cosmetics industry for protective creams, to the safety clothing designers for gloves and garments, and to the laboratory for new techniques in sterilization and control. At the same time, skin types were studied; some persons, notably red heads, have ultra sensitive skins and are far more liable to infection than deep brunettes.

Step by step, methods through whole plants were adjusted for dermatitis control. Parts cleaning solutions were changed, men found especially sensitive were shifted to jobs in which their skins did not come into contact with oils, splashing by various machines was stopped by the application of shields, and so on. As a result, some medical departments which formerly had dermatitis as major problems, now almost never see a case.

The modern method of tilting and positioning work to be welded lets the welder work with greater safety, comfort, accuracy and speed. (Courtesy: Westinghouse Elec. & Mfg. Co.)

Methods Engineering and Product Design

The methods council has its part in special developments and in product design, too.

Recently a shipyard was told of the need of a special crankshaft for the experimental model of a Diesel engine. Development work on the engine threatened to be held up, for the necessary forging could not be obtained, and only slow equipment was available in the experimental department to finish the bearing surfaces. But when the problem was put up to the methods council, a steel billet of the proper analysis was found available. Flame cutting was used to cut the rough crankshaft form from this billet. And while the flame cutting procedure was being laid out for the guidance of the machine operator, the methods engineer discussed secondary operations with the supervisors of machining and grinding departments.

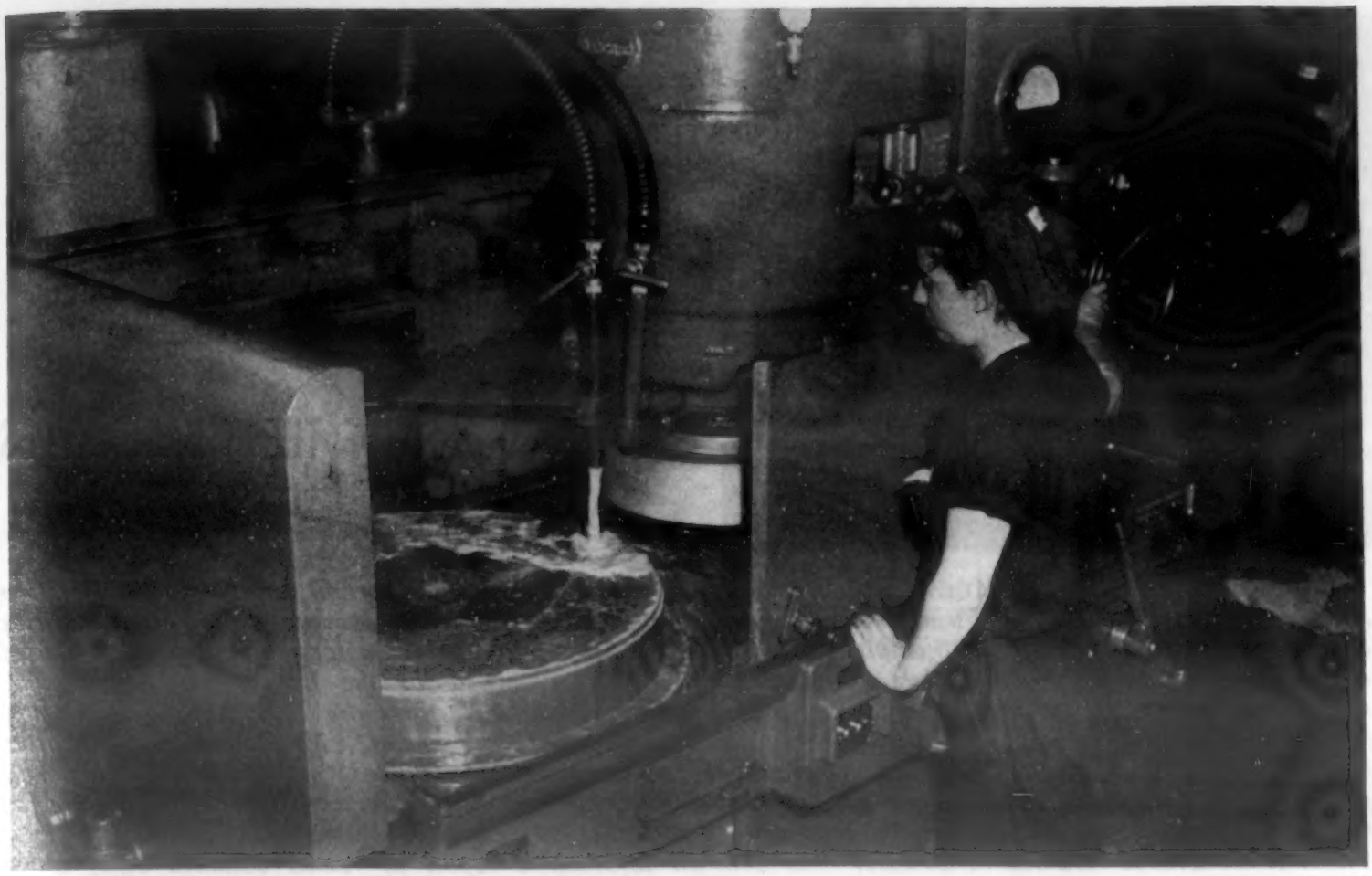
These men pointed out that with the changes of a few minor details this shaft would have much the same control surfaces as some of their regular ones, and that by using only their most experienced machine operators they could turn it out in much less time than if it were to be wholly machined in the experimental department. As a result, with design changes entirely satisfactory to the experimental engineer, the methods engineer worked out a plan by which the shaft went down the regular production line with only a few operations on it assigned to the tool room, and was finished within a few hours of delivery of the flame-cut rough form instead of taking several weeks or more.

In more and more cases the methods engineer works closely with the experimental and development departments, and takes new product problems up with the methods council. This is an entirely different procedure from the old fashioned way of having brand new products dumped into the methods engineer's lap, then having him call for revisions until he had something which the plant could produce—classic examples of which are found in the multitudes of "special" automobile engines which were changed and changed again to lower their production costs until they finally emerged as ordinary L-head types.

When production methods are evolved right along with product designs, the machine part which is too costly to produce is eliminated or modified before it becomes "indispensable to the design." And in a surprising number of instances, the methods engineer finds ways to make parts which the development men themselves would have discarded as being too difficult to manufacture. Thus the finished design finds the production agenda all ready for it, and product and methods engineering become integral functions.

The methods engineer has his own segment of research, and combs the entire field of new developments for devices which will permit new methods to be evolved.

An example of this is the control of rotating speeds. All sorts of devices for this are on the market, but most of them require arbitrary speed settings—whether



A faster wheel here let methods engineering increase the speeds in two other departments.

manual or automatic—with only lagging readjustment to true speed if the power demand on the device changes enough to cause motor slip or otherwise alter speeds. But applied to elevator drives was a Westinghouse device known as the Rototrol which translates the power demanded of a d-c motor into instant changes in the power applied by the motor, thus keeping the motor at exactly constant speeds or causing it to follow predetermined patterns of speed changes.

Methods engineers took this out of the elevator shaft and brought it into the factory to keep metal planers constant in speed during the cutting stroke but rapidly accelerating and decelerating when the bed returns, keep the feeding mechanisms of machine tools to exactly adjusted speed patterns, hold paper slitting and winding machines to ideal speeds, and perform dozens of other tasks. This device did not reduce the values of other forms of speed adjusters, but rather permitted the methods engineers to find more uses for them. And as usually is the case, with this new device in the field, speed control became a subject for review by methods councils, and speeds of processes throughout whole plants were adapted and synchronized to each other as never before.

The Future

Business leaders are fearful of the problems of post-war reconversions of plants. But engineers cite such examples as the jet propulsion airplane (rocket plane) which is a brand new development yet was gotten ready for war in less than two years. General Electric, a pioneer of methods engineering, had the engine of that plane ready in only six months from receipt of the secret specifications. And methods engineers, those masters of sequences and coordinators of engineering brain power, are performing similar miracles every week.

No one now knows just how much the new technique of methods engineering ultimately will affect manufacturing. An analysis made by a large maker of electrical products showed that over 85% of the suggestions found in the suggestion boxes had to do with methods and were submitted to the methods council. Methods thinking dominates industry.

And just how far methods engineering has gone can be shown by some fairly husky straws in the wind. Thus the Office of Civilian Requirements says that 2,000,000 electric irons will be made in the first nine months of 1944, and calmly assumes that the industry will convert from war work and make them. General Motors president Alfred P. Sloan says his company will spend $250,000,000 right after Victory Day and convert to the production of automobiles within four months. Bendix Aviation now has 2,500 men on its engineering staff, and most of them are methods men; on this foundation it expects to enter the post-war world with war-born products which will change the courses of the aircraft, automobile and radio industries.

It is no wonder, then, that industrialists are saying that methods engineering is winning the war, will win the peace, and is the single greatest advance in management technique.

THE FIRST GROUP IN A SERIES OF FEATURE ARTICLES ON INDUCTION HEATING

Induction Heating Equipment

—FIELDS OF USE OF THE 3 BASIC TYPES

In this issue the Editors of METALS AND ALLOYS *present the first in an important series of several feature articles on various phases of the war-broadened field of induction heating. This opening group of three articles covers the selection of the type of equipment for different applications from among the three basic classes of high-frequency equipment available. The brief introductory article by the Editors provides a quick review of the overall job induction heating is now doing, broadly classifies the equipment available and identifies individual manufacturers with the type or types of unit each makes. Mr. Jordan then discusses the fields of use of the motor-generator set and of the vacuum tube oscillator for induction heating, and gives several illustrative examples of intelligent choices of each type. Mr. Chesnut completes the picture for this issue with some concise engineering information about the applicability of spark-gap converters.*

The series will be resumed in an early issue with an informative report of results obtained using ultra-high-frequency (megacycles) equipment of the electronic type for thin surface hardening, and will continue thereafter with other articles on this important engineering and production tool. —*The Editors*

The Field as a Whole

by THE EDITORS

THE FIELD OF INDUCTION heating has developed so rapidly in the last ten or fifteen years that many engineers feel a need for some definition of the actual utility of induction heating and of its limitations and advantages for specific types of work. This need for definitive information is particularly recognized when a prospective user of the process is faced with the problem of deciding which of the three basic types of induction unit — motor-generator set, vacuum tube oscillator or spark-gap converter — is the best for his particular situation.

The problem is complicated by other factors too — some segments of the field are still in a state of development, and do not yet know their own strength or weakness; one branch (the electronic-tube equipment) has been over--glamorized by "popular" writers and speakers to an extent that has put manufacturers of such equipment cautiously on the watch for misapplication; the spark-gap type of equipment has often been insufficiently considered in view of its very real merit for certain types of work, etc.

Fig. 1. High frequency induction furnaces of this type, powered by motor-generator sets, are widely used for the melting of high quality alloy steels for munitions applications. (Courtesy: Ajax Electrothermic Corp.)

It is also easy to forget, in view of the wave of interest in electronic type equipment and recent technical advances in spark-gap units, that the motor-generator set continues to supply the large majority of the total power used for induction heating and melting applications on metals and that the use of continuous or automatic and semi-automatic motor-generator-powered units of often surprising flexibility is steadily increasing. Some of these typical wartime applications of such machines are illustrated in the pictures that accompany this article.

Induction heating in general is of special interest where it is desired to

(a) locally heat or harden a selected area or a controllable surface depth of steel, the rest of the material remaining soft,

(b) to through-heat a part or section (especially tubing) of not too great thickness rapidly and without excessive scaling,

(c) to heat joint areas to be brazed or soldered where the heat-affected region should be sharply restricted or where rapid or automatic heating is otherwise required.

Fig. 2. At a Curtiss propeller plant, tubular blade shanks are heated for forging to a temperature of 2,000 deg. F. in 115 seconds, using the induction equipment (motor-generator type) shown here. (Courtesy: Tocco Div., The Ohio Crankshaft Co.)

Types, Manufacturers and Applications of Induction Heating Equipment

Types	Manufacturers	Typical Applications on Metals
otor-Generator Sets (Frequencies: 50 - 60 cycles; power ratings up to 500 kw.)	Ajax Electric Furnace Corp., Philadelphia	Melting brass and other nonferrous alloys
	Ajax Engineering Corp., Trenton, N. J.	Melting aluminum and its alloys
otor-Generator Sets (60-12,000 cycles; 20-1,000 kw.)	Ajax Electrothermic Corp., Trenton, N. J. Budd Induction Heating, Inc., Detroit General Electric Co., Schenectady, N. Y. Tocco Div., The Ohio Crankshaft Co., Cleveland Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.	Melting alloy steels, nickel alloys, etc. Melting foundry bronzes and brasses Surface hardening large and small shafts, pins, gears, bearing races, dies and punches, etc. Internal hardening of cylinder bores Hardening large crankshaft journals Hardening armor-piercing shot Hardening tractor sprockets Heating large nonferrous stock for forging Mouth annealing of 3 in. shell cases Nosing shells Heating for forging propeller blade shanks Brazing mortar shell adapters Brazing carbide tool tips
Spark-gap Converters (15,000 - 300,000 cycles; 2-40 kw.)	Ajax Electrothermic Corp., Trenton, N. J. Cyclonics Mfg. Co., Union City, N. J. Ecco High Frequency Corp., N. Bergen, N. J. Lepel High Frequency Labs., Inc., New York Scientific Electric Div., "S" Corrugated Quenched Gap Co., Garfield, N. J. Van Norman Company, Springfield, Mass.	Small melts of ferrous and nonferrous alloys Surface hardening of shafts, gears, pins and other hardening applications, similar to m.g. uses Heating of small nonferrous parts Brazing high speed steel drills Soldering 5-gallon cans Heating small steel parts for forging
Electronic Tube Converters (100,000 - 15 million cycles; 5-60 kw.)	Ajax Electrothermic Corp., Trenton, N. J. Federal Tel. & Radio Corp., Newark, N. J. General Electric Co., Schenectady, N. Y. Illinois Tool Works, Chicago Induction Heating Corp., New York RCA Victor Div., Camden, N. J. Scientific Electric Div., "S" Corrugated Quenched Gap Co., Garfield, N. J. Tocco Div., The Ohio Crankshaft Co., Cleveland Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.	Very thin or selective surface hardening Many surface hardening jobs listed above Flowing of electrotinplate Brazing bazooka ammunition Heating nonferrous materials Degassing radio tube parts

These have led to dozens of applications where induction heating has been more economical or has given greater production or has resulted in better part quality than did other methods. Products of intricate design can often be properly hardened only by induction heating. The method obviates the use of plated stop-offs; it has frequently eliminated carburizing treatments. It is so fast that it makes unnecessary the use of controlled atmosphere furnaces or of expensive subsequent machining, straightening or cleaning operations.

During the war induction heating has furthered conservation by permitting the development of hardnesses and surface wearing properties in low-alloy or plain carbon steels that normally could be obtained only by carburizing or hardening high-alloy steels.

The broad processes in which the foregoing advantages of induction heating have been most usefully employed may be listed, as follows:

Selective or surface hardening of steel
Annealing or softening small (though sometimes large) areas of both ferrous and nonferrous metals, often for forging or hot-working
Brazing similar and dissimilar metals to each other
Melting metals — ferrous and nonferrous
Heating (sintering) of powder metallurgy products, *e.g.* tungsten carbide shapes
De-gassing of assemblies of metal-parts, as in the manufacture of vacuum tubes

The fields of applications of the three types of equipment are discussed in the two articles just following this. To avoid misunderstanding and as a general guide to the reader interested in knowing who makes what we are including in this article a Table (complete to the best of our knowledge) showing the manufacturers of induction equipment for heating or melting metals and the type of equipment made by each, together with some typical specific applications for the respective kinds of equipment.

Fig. 3. Here is a brazing application of an electronic-type induction heater — the joining of a sleeve to a torque tube. (Courtesy: General Electric Co.)

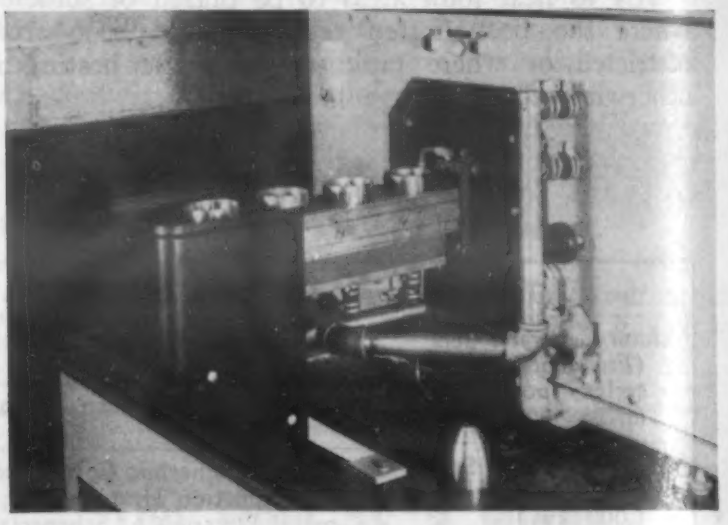


Fig. 4. For the differential hardening of large armor-piercing shot caps, in which the skirt is left soft for crimping on to the shot, induction heating units of this type (motor-generator powered) are highly useful. The 4-position fixture speeds production. (Courtesy: Tocco Div., The Ohio Crankshaft Co.)

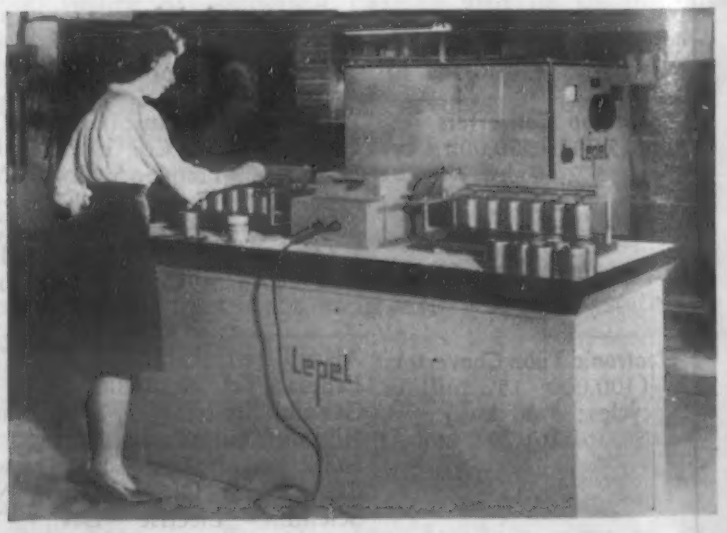


Fig. 5. Silver brazing a tube inside a cup stamping is a typical interesting job being done by spark-gap induction heating equipment. (Courtesy: Lepel High Frequency Laboratories, Inc.)

Motor Generator and Electronic Units

by J. P. JORDAN

Industrial Heating Engineering Div., General Electric Co., Schenectady, N. Y.

THE EARLIEST APPLICATIONS of induction heating of metals utilized available line frequencies of 25 and 50 cycles per second for the heating of large masses. Because of the severe limitations of such heating, motor-generator sets were designed to convert these frequencies to higher frequencies, on the order of 1000 to 3000 cycles per sec. More recently, generators supplying up to 10,000-12,000 cycles per sec. and spark-gap equipments supplying up to 200,000 or 300,000 cycles per sec. at low powers have been placed in service.

The newcomer to the field, the electronic heater, has extended the frequency range to millions of cycles per second at almost any desired power level. In the frequency range of 100,000 to 300,000 cycles it competes to some extent with spark gap equipment.

Since each type of power source is best suited for certain classes of work, which overlap in many cases, the potential user of induction heating equipment is faced with the problem of deciding which will best meet his requirements. It seems timely, therefore, that some attempt be made to define the fields of application of the available equipment.

Some General Comparisons

For the purposes of such a definition, the equipment can be roughly divided by frequency into two classes: motor-generator sets and low-frequency spark-gap units on one hand and the electronic heaters on the other. No attempt will be made here to differentiate between the various frequencies available in these classes since each is a complete study in itself, nor indeed will this article concern itself with the field for spark-gap converters, since these are separately discussed in another article in this issue. With all this in mind, certain general observations can be stated:

1. Motor-generator sets are, at present, slightly less expensive in initial cost than are oscillators of the same power rating.
2. Maintenance costs are definitely higher for oscillator (electronic heater) equipments, averaging from 10 to 50c per hr. of operation for electronic heaters, depending on tube complements and ratings used.
3. Overall power conversion efficiencies are higher for motor-generator equipments, running up to 85% as compared to approximately 55% maximum for electronic heaters.
4. Inductor coil costs are in general somewhat higher for motor-generator equipment, because of the higher currents used.
5. The high noise level adjacent to motor-generator sets, due to the high speeds necessary, may be a disadvantage in otherwise quiet locations. Most oscillator equipments operate without sound or vibration.
6. Depth of heating varies inversely with the square root of frequency; thus a motor-generator operating at 10,000 cycles per sec. develops a heat initially in a zone approximately 7 times deeper than an electronic heater operating at 500,000 cycles per sec.
7. With a given inductor coil and charge, much higher currents are necessary at the lower frequencies to produce a desired heating effect, necessitating heavier coils. Thus, it is easier to induce heat in restricted areas with the higher frequencies.

To further simplify the analysis, the metals to be heated will be divided into two classes, ferrous and non-ferrous, with the ferrous metals being treated first.

General Fields of Use

Certain types of heating operations can be immediately assigned to either one class of equipment or the other. The melting of metals other than for analytical purposes, through heating of large masses for annealing or forging, and the deep surface hardening of shafts and other parts having no sharp contours, are definitely low-frequency operations and should be applied to motor-generator equipment for both economical and theoretical reasons.

If high-frequency oscillators were applied to the heating of bars over 2 in. in diam. for forging operations, the rate of heat input would have to be relatively small to prevent severe overheating of the surface layers, thus considerably increasing the heating time. Such applications call for uniform temperatures through a large mass, thus making the deep heating characteristics of the low-frequency equipment of distinct advantage.

Surface hardening where a very thin case is required (less than 1/16 in.) or where a uniformly hardened area is desired around sharp contours, and in the heating, in general, of parts less than approximately 3/8 in. in diam. or of sheet stock less than 1/8 in. thick, require the use of the higher frequencies which can only be supplied by electronic heating equipment.

Of the extensive group of work remaining, no general classification is possible. The surface hardening of shafts between 3/8 in. and 2 in. and the general heating of many small parts, can be done equally well with either type of equipment. In some cases, the extreme localization of heat possible with the electronic heater type of equipment or the difficulty of inducing sufficient heat into an irregularly shaped part with the lower frequencies may be the deciding factor. In many cases, the lower investment and operating cost of the motor-generator set permits no other choice. However, it is generally more economical to use electronic heaters where power requirements are in the range below 15.

Fig. 6. A small gear being placed in the coil of an induction heater (vacuum-tube type) for surface hardening. (Courtesy: General Electric Co.)

In the field of non-ferrous metals the choice is often easier. Low-resistance metals, such as copper and brass, are best heated with electronic heating equipment in almost all cases. The high-resistance materials, such as carbon, tungsten, nickel, etc., can be heated with motor-generator sets if the part is relatively large. In such cases, the determining factor is the ability to induce sufficient heat into the specific part, which depends on the size and shape of the part and the rate of heating desired.

One further consideration is of importance in cases where a variety of work is to be done and the total production can be handled by one equipment. Even though the majority of the work contemplated falls into that group which can be performed equally well with either equipment, the remainder must be the determining factor. Thus, in some instances, the higher cost of the electronic heating equipment will be warranted to allow its use on all of the jobs being considered, even though the major applications will be such as to be easily done with the motor-generator sets.

Some Practical Applications

By way of illustration, several applications have been chosen where the decision regarding type of equipment to be used was dictated by the above considerations.

In one plant, the major part under consideration was the torque tube shown in Fig. 3. Originally, this part was fabricated by arc welding from a steel tube, two end plugs, and a sleeve to eliminate the waste of steel inherent in machining such a part from bar stock and to reduce the weight. However, the welding costs proved high and induction brazing was decided upon. This part, being approximately 2 in. o.d. and requiring three heating operations, was clearly on the border-line between those applications suitable for motor-generator equipment or electronic heaters, with some theoretical advantage in favor of the motor-generator equipment because of its deeper heating characteristics.

However, because of the speed of induction brazing, it was estimated that the equipment would be in use only two days a week to meet the production demands — previously requiring the full-time efforts of a welder six days a week. Thus, other possible applications within the factory were investigated and found to consist largely of the surface hardening of small shafts and spur and bevel gears. (See Figs. 6 and 7). These parts could not be readily heated using the motor-generator sets since they involved sharp contours and small diameters, and because their great variety necessitated use of many different sizes and shapes of heater coils. Thus, even though the primary application involved the heating of a 2-in. tube which could have been easily handled with motor-generator equipment, the electronic heater was the obvious choice. More than a year's satisfactory operation has confirmed this application.

In another case, it was decided to use induction heating equipment for two operations, namely, surface hardening sections of shafts ¾ in. in diam. to a depth of approximately 0.040 in. and heating the ends of rods ranging from ¾ to 3 in. in diam. for a forging operation. The hardening operation obviously fell in the class of those applications best performed by electronic heaters, since it is difficult to obtain a hardened zone on the order of 0.040 in. deep with motor-generator sets.

However, the deep heating characteristics of the motor-generator equipment would be a distinct advantage for the forging operation, particularly in the larger sizes where overheating of the surfaces would prevent the use of high rates of power input with electronic oscillators. On investigation, it was found that while the forging operation was the major application, there was not a great enough volume of work involved to warrant purchase of two different types of equipment. Thus, some compromise was necessary, and since the hardening operation was the lesser, it was decided to raise the 0.040 in. depth of hardening requirements and use motor-generator equipment.

Another application entailed the continuous heating of steel tubing and wire in sizes below ⅜ in. for annealing. The larger sizes could be heated with the low-frequency equipment, but when the temperature reached the magnetic point beyond which the steel lost its magnetic properties (1420 deg. F. for low-carbon steel), the rate of heat input dropped to a very low value. Thus, to eliminate this difficulty, the higher frequencies were necessary and electronic heaters were applied.

In general, there is a large field of applications in which no great harm will be done regardless of the equipment applied. The advantages of one type over the other for such uses are relatively minor. However, where the application is best suited to one equipment, the use of the wrong type will, in almost all cases, give unsatisfactory results and prejudice the further use of induction heat.

Spark-Gap Converters

by FRANK T. CHESNUT

Secretary, Ajax Electrothermic Corp., Trenton, N. J.

RAPIDLY BECOMING AN essential part of every production line where heat is required, induction heating equipment will soon be as familiar to industry as machine tools or welding equipment. Selection of "packaged" or tailored units to do general or specific heating jobs for forging, melting, heat-treating, brazing, or countless other operations will soon become every management's job.

At present, equipment using high-frequency motor-generator sets as the source of power are handling the bulk of the induction heating work — jobs such as heating for forging, high-speed production melting, annealing, etc. But the "packaged" spark-gap converter fills an important position in handling the lighter jobs — such as heat-treating and production heating of small parts up to 1½ in. diameter, and small-scale production or laboratory melting.

With frequencies ranging from 15,000 to 60,000 cycles and power capacities ranging from 3 to 40 kw., spark-gap sets are an economical power source for jobs requiring intermediate frequencies between the 12,000-cycle limit of motor-generators and the higher radio frequencies supplied by tube converters. While vacuum tube equipments are required for dielectric heating and certain small parts, a surprisingly large proportion of induction heating jobs can be accomplished more economically and more efficiently with generator and converter-operated equipment.

The resonant spark-gap oscillator of the mercury-hydrogen type was developed by Dr. E. F. Northrup in 1916, over a quarter of a century ago, for low-power, high-frequency heating. As developed to date, it has no moving parts, and is housed in a sturdy steel cubicle. Control of power in the mercury-hydrogen unit is obtained by turning a hand-wheel which regulates the volume of mercury in the discharge gap chamber.

Sizes of mercury-hydrogen converters are limited at present to 40-kw.; standard sizes are 3, 6, 20 and 40 kw., rated on power input. Overloads of as high as 25 percent can be maintained under favorable conditions.

In some instances, where low power at slightly higher frequencies is required, the quenched-gap type of converter is effective. These sets are available in frequencies from 100,000 to 400,000 cycles per second, and power capacities up to 32 kw. Applications of spark-gap converters above 300,000 cycles are rare, however.

Applications

Principal applications of the spark-gap converter for high-frequency heating can be divided roughly into the classifications shown in the Table. Ranges of sizes of parts that can be handled with available capacities and frequencies of spark-gap sets are indicated. In general, larger parts and operations require motor-generators rather than spark-gap units. Similarly, operations on very small parts, self-quench hardening, and dielectric heating will call for tube converters.

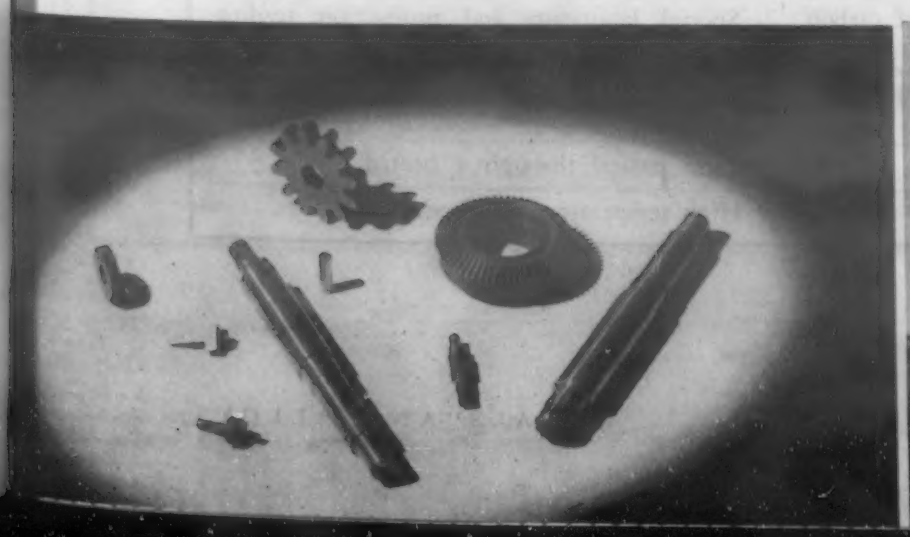
The flexibility of the spark-gap unit in average metal-working operations is vividly demonstrated by the accompanying Table of applications. By simply changing the holding coil jig and the inductor coil — a matter of a few minutes' work — one standard spark-gap set can handle a wide variety of operations ranging from brazing, surface hardening and forging to melting or sintering. Or applications ranging all the way from drying the coatings on welding rod or brazing tin cans, to hardening noses on armor-piercing shells.

This flexibility is a very important factor in selection of equipment in plants where production quantities are small or where quick changeovers from one job to another will frequently be required of the induction heating equipment. The spark-gap units are compact and can easily be shifted around the plant. Sets up to 6 kw. can be mounted on casters. All that are required to hook them up are power line and cooling water connections.

Standard spark-gap power sources and special work coils can easily be combined into one compact

Fig. 7. A few of the parts now being selectively hardened using electronic tube induction equipment. The etched surface on the spur gear shows the hardened area. (Courtesy: General Electric Co.)

Fig. 8. This 6-kw. spark-gap type induction heater hardens the ordnance part illustrated in 35 seconds. (Courtesy: Ajax Electrothermic Corp.)



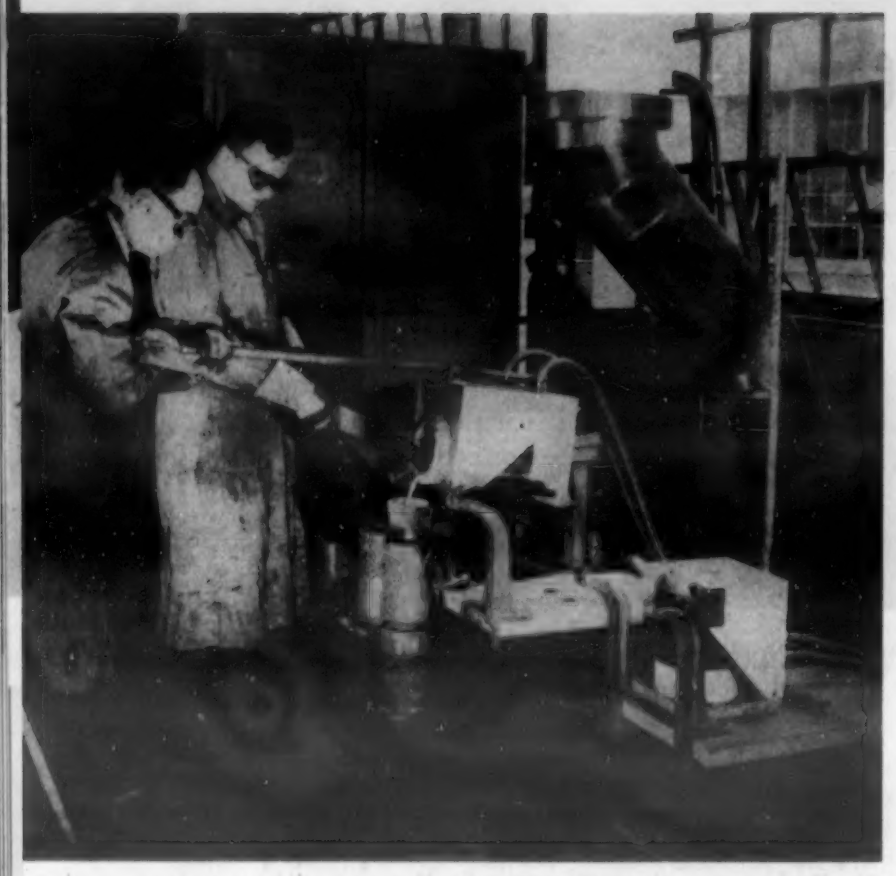
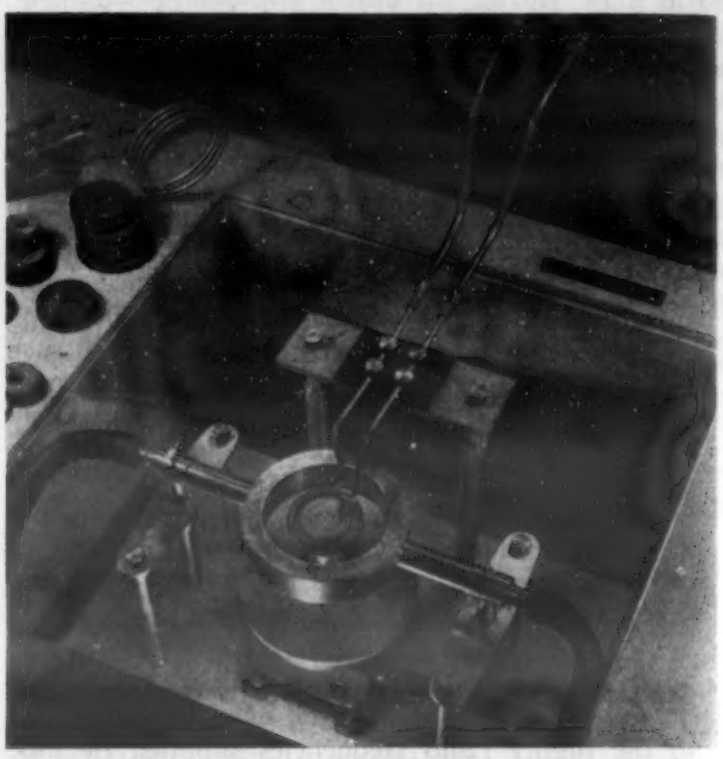


Fig. 9. Spark-gap power sources are excellent for small-quantity melting such as is done in this 17-lb. induction furnace. (Courtesy: Ajax Electrothermic Corp.)

unit for greater efficiency on production lines. An example of this is found in a highly successful self-contained 6-kw. unit which produces six perfectly brazed joints each minute.

Induction heating equipment lends itself readily to design of efficient, neat and attractive work stations. The heating furnace or work coil can be located right on the production line, with fully automatic and accurately controlled operation resulting in speedy, uniform production. There is no limit to the possible designs of work holding devices, conveyor systems, or other attachments that take full advantage of the high speed, uniformity, and clean work of induction heating.

Fig. 10. A spark-gap induction heating set-up for hardening gears and similar parts. To insure uniform heating the gear may be rotated at predetermined speed within the heater coils during the automatically controlled heating and quenching cycles. (Courtesy: Lepel High Frequency Laboratories, Inc.)



Application of Spark-Gap Converters in Induction Heating
(Frequencies from 15,000 to 60,000 cycles)

Applications	*Size Range of Parts*	*Notes*
Brazing, Soldering, Welding	Small, irregular parts to medium-sized regular shapes where heat must be localized.	Examples: brazing bourdon tubes, shell adapters, and countless others.
Forging, Upsetting Bars Tubes	From ¼ to ½ in. dia. Up to 1 in. dia.; wall thickness to ¼ in.	Through-heating. Parts larger than 1 in. dia. can be done more economically with motor-generator frequencies below 12,000 cycles.
Hardening, Surface	Thin and average case hardening on parts to 1½ in. dia. Localized or continuous.	Countless applications on small parts, small and large production quantities.
Hardening, Through	Thin-wall tubes and parts up to 1½ in. dia.	Same principles apply as for heating for forging. See above.
High-Temperature Heating	Calibration studies, graphitization of carbon, vaporization study.	Special laboratory and production applications. Temperature to 2500° C. and over.
Melting	Laboratory and small-production quantities up to 50 lb. Rare metals.	Larger quantities require higher power and lower frequencies of motor-generators.
Muffle Heating	Small parts, wire, etc.	Parts passed through a heated muffle.
Sintering	Carbides, etc.	High temperature required.

METALS and ALLOYS

Engineering File Facts

NUMBER 46
May, 1944

GENERAL ENGINEERING DATA

Electronics Applications in the Metal Industries

One of the tools of science and industry "glamorized" by the war is the electron tube. Its present applications cover a wide range, and possibilities are even wider. However, leaders in the electronics field are already warning that it is not a "cure-all," and are urging that its applications be kept upon a solid basis.

Electronics deals with the motion of the electron in space. In certain uses the particles are not electrons, as in the electrical precipitator and the cyclotron, but in general such a definition would hold. The most common means of utilizing this motion is the electron tube.

The electron tube may be thought of, in a general way, as a super-switch, which may not only open or close, but regulate, amplify, or change the direction of the current. It may be actuated by a controlling current, or by light, and provides a means for measuring either, or changing one into the other. Of course, a single electron tube will not do all of these things, but the proper selection of tube or combination of tubes, in a correctly designed circuit, gives electronics very wide applicability.

The tubes are customarily used in groups, each tube with a specific function. For the engineer in the metal industries making use of electronic devices, they should be thought of not as collections of tubes, but as carefully designed units intended to perform a given task, for the resistances, condensers and inductances in the circuit are as vital to its performance as the tubes. He will be interested in electronics primarily as electronic devices and their uses. The following tabulation is not complete as to applications, since new ones are made continually, but serves as a guide as to types.

General Function	Device Used	Typical Applications
High Frequency Heating	Rectifiers (usually mercury vapor) and vacuum tube oscillators	(1) Heat treating of metals—surface hardening, annealing, etc.; (2) welding, brazing, and soldering; (3) flowing of electroplated tin; (4) dielectric heating—bonding of plywood, heating of plastics, etc.
Measurement	Electronic micrometers	Part inspection.
	Amplifying circuit, stroboscopic light, etc.	For locating and measuring unbalance in all types of rotating parts—dynetric balancing.
	Cathode-ray oscilloscope	Electrical circuit analysis. Recording device for many electronics circuits—permanent records can be made on a photographic plate. Television screen.
	Synchronous light and power timing unit	Motion analysis—rotating or reciprocating parts visually stopped or slowed down for study—Stroboglow—also for speed measurement.
	Phototube units and amplifiers	Light measurements—color measurements.
	Microphone-amplifier unit	Sound measurement.
	Electrostatic or electromagnetic lens—electron gun—cathode-ray screen	Study of small particles—the electron microscope.
	Piezo-electric crystal-amplifier-indicator unit	Measurements of pressures, from very small to very large, as in artillery design—measurements of sound or motion.
Control	Photo-electric devices	(1) Lighting controls; (2) smoke recorders and furnace controls; (3) guides or break indicators for continuous web equipment, as in steel strip mills; (4) furnace firing controls actuated by light from fire-box; (5) safety devices, speed, positioning, or shape regulators, etc.
	Weld current timers	Control of resistance welding sequences, etc.
	Current rectifier—speed control unit	Speed control of electrical equipment.
	Pyrometer-amplifier unit	Furnace temperature control through saturable core reactor, etc.
Rectification	Pumped ignitron rectifiers, pool tube, etc.	Large capacity a.c. to d.c. conversion.
	Sealed ignitron, tungar, kenotron, etc. rectifiers.	Small capacity a.c. to d.c. conversion.
Inspection, Sorting	X-ray apparatus	Inspection of castings, welds, assemblies, armor plate, etc.
	Photo-electric devices	Pin-hole detectors for sheets, counting devices, mechanisms for sorting on a color basis, etc.
	Electromagnetic, etc. testing devices—cathode-ray or other indicator	For comparing metal samples with standard—cyclograph, etc.
	Oscillator-amplifier mechanical testing unit	Vibration fatigue testing of structural and rotating parts.
Precipitation	Electrodes to charge and remove suspended particles	Removal of dirt and dust, oil droplets, etc., from air; removal of soot, chemicals, metal particles, etc., from stack gases—Precipitron, Cottrell precipitators, etc.
Radiation	Fluorescent chemical activated by electronic discharge	Industrial lighting, etc.—the fluorescent lamp.
	Vapor of sodium, mercury, etc., or neon, argon activated by electronic discharge	Special lighting applications—the sodium-vapor lamp, mercury-vapor lamp, neon lamp, etc.
	Ultra-violet radiation produced by mercury-vapor lamp	Sterilizing of cutting oils, etc.—Sterilamp, etc.
Inversion	Rectifier-inverter unit	Changing d.c. to a.c., frequency changing, telemetering, etc.

Compiled by Kenneth Rose, Engineering Editor

When It's Bronze We Can Make It

N·B·M BRONZE PARTS

in all shapes and sizes

NBM

NATIONAL BEARING METALS CORPORATION

ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

METALS and ALLOYS
Engineering File Facts
NUMBER 47
May, 1944

Copper Alloy Castings—II

Part I of this two-part series on cast copper alloys appears as Engineering File Facts No. 44 in the April issue. Data on the composition and uses of the alloys tabulated will be found on pages 887 and 889.

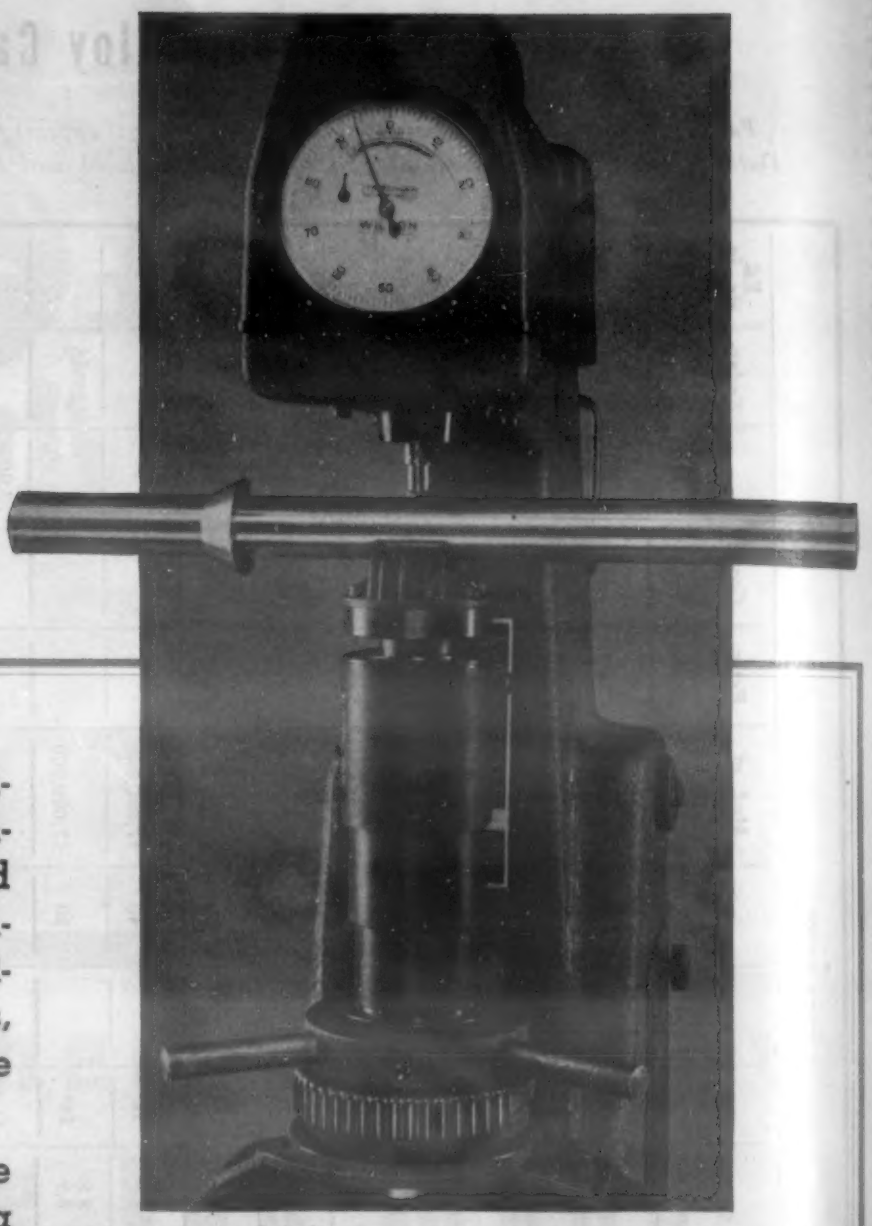
TYPE		PROPERTIES															
		Propor. limit, p.s.i.	*Ten. str., p.s.i.*	*Yield point, p.s.i.*	*Elong., % in 2 in.*	*Brin. hardness*	*Specific gravity*	*Elec. cond., %*	*Thermal cond.*	*Reduction of area, %*	*Mod. of elasticity, p.s.i.*	*Resis. to impact, ft.-lb.*	*Coeff. thermal exp.*	*Compressive stress**	*Endurance limit, p.s.i.*	*Yd. str. in compression p.s.i.*
Nickel brasses	1	18,000[12]	45,000	27,000	15.0	95[3]	8.7	5[4]	10[13]	20.0	15,000,000	25[21]	0.000-010[9]		5,000	12,000
	2		45,000	20,000	35.0	55[3]										
	3	15,000[12]	40,000	25,000	15.0	100[3]	8.7	5[4]	10[13]	20.0	12,000,000	10[21]	0.000-010[9]		4,000	8,000
	4	15,000[12]	40,000	25,000	15.0	100[3]	8.7	5[4]	10[13]	20.0	13,000,000	15[21]	0.000-010[9]		4,000	8,000
	5		55,000	40,000	10.0	140										
	6	20,000[12]	63,000	32,000	35	117[3]	8.8	5[4]	10[13]	45	20,000,000	30[21]	0.000-010[9]		15,000	15,000
	7	20,000[12]	60,000	30,000	12	120[3]	8.7	5[4]	10[13]	18	19,000,000	30[21]	0.000-010[9]		15,000	15,000
Nickel bronze	as-cast	15,000[12]	47,000	22,000	45	85[3]	8.8-8.9	12[4]		40	17,000,000					
	heat treated	35,000[12]	75,000	55,000	20	148[3]	8.8-8.9	16[4]		20	17,000,000					
Tin bronze	1	11,000-14,000	35,000-45,000	16,000-23,000	20-40	65-85		11-13		15-35	15,000,000	7-10[20]		13,000-17,000		
	2		33,000-45,000	18,000-26,000	7-15	60-80		10-11		5-13		3-6[20]		16,000-22,000		
	3		25,000-35,000	18,000-32,000	0-1.5	70-160		6.5-7.5		0-1.2		0.5-1.3[20]		24,000-30,000		
	4		51,000	27,000	18	100										
High lead, tin bronze	1	8,000-10,000	29,000-35,000	15,000 21,000	8-14	55-65		9		8-14		4-8[20]		13,000-16,000		
	2	6,000-8,000	22,000-32,000	8,000-20,000	9-15	45-70		11		9-15		3-6[20]		14,000-16,000		
	3		7,000-23,000	4,000-11,000	3-16	30-45				5-18				4,000-10,000		
	4		6,000		15	28				16						
Aluminum bronze (sand cast)	1	20,000[12]	70,000	35,000[15]	25	70[16]	7.6			25	18,000,000					
	2	20,000[12]	70,000	30,000[15]	20	110[16]	7.5		15	20	15,000,000	30-36[20]	0.000-0091[18]		2800-4200[17]	

* Compressive stress for 0.001-in. (Deformation of a 1-in. cube, per sq. in.)

(Continued on page 1163)

Now... "File-HARD" STAINLESS

which retains corrosion resistance!



This Stainless Steel piston for a compression molding machine has an unenviable responsibility: it is expected to perform as smoothly as a watch under all conceivable hardships, including abrasion, wear, high temperatures, and pressures up to a relentless five hundred tons!

Normally you would compute the life of such a piston to be limited to a relatively few operational hours . . . and you would be right *except for the fact that it has been fortified by the INDUSTRIAL SURFACE HARDENING PROCESS.* That means that it has been equipped with a "file-hard" (91 to 97 Rockwell 15-N) surface which has not only the corrosion resistance expected of Stainless Steel, but also the unusual virtue of being as hard and uncompromising as glass.

If you want to make the service life of your Stainless Steel gears, shafts, bearings, instrument parts, pump and valve parts longer and more efficient, send them to us for **SURFACE HARDENING.**

For more detailed information, write us directly.

INDUSTRIAL STEELS, INC.

250 BENT STREET CAMBRIDGE, MASS.

THE INDUSTRIAL PROCESS • FOR SURFACE HARDENING STAINLESS STEEL PARTS

TYPE		COMPOSITION, PER CENT													USES
		Cu	*Zn*	*Sn*	*Pb*	*Fe*	*Si*	*P*	*Sb*	*Ni*	*S*	*Impurities*	*Al*	*Mn*	
Nickel Brasses	1	62.0-65.0	6.0-10.0	2.5-4.0	5.0-6.0	1.0M		0.05M		19.0-20.0				1.0M	Alloys 1, 2, 3, 4 and 5 are used for plumbing, fitting, marine hardware and ornamental (white color) work; textile, laundry and filling machine parts and dairy equipment; and chemical pumps and fittings. Alloy 6 is used in marine service, and alloy 7 for high-temperature corrosion resistant work.
	2	55.0-64.0	20.0			1.00M		0.05M		18.0-20.0			0.00M		
	3	55.0	20.0	2.0	10.0	1.00		0.05M		13.0					
	4	55.0	18.0	4.0	8.0	1.00M		0.05M		15.0				1.50M	
	5	56.0	15.0	4.0	1.0			0.05M		20.0					
	6	Rem.	1.00M	1.0M	0.05M	1.00-1.25	0.25-0.75			28.5-31.5	C 0.15 M		0.05M	0.60-1.20	
	7	33.0		13.0						54.0					
Nickel Bronze		88.0	2.0	0.00-0.01				0.05		5.0					Used (as-heat-treated) in worm gears and other heavy-stock services and for bridge plates and corrosion-resisting parts.
Tin Bronze	1	87.00-89.00	1.50-4.50	7.50-10.50	0-2.00	0-0.25		0-0.05		0-1.00		0-0.50			Alloy 1 is used for valves and steam fittings under 500 deg. F., pump and piston parts for steam and vs. sea water corrosion; low-speed, high-load bearings, and gears. Alloy 2 is used for bearings, gears and worm wheels. Alloy 3 is used most widely for bridge bearings, and alloy 4 is a chill-cast, shock-resistant composition for worm gears.
	2	86.00-90.00	0-1.00	10.00-14.00	0-0.50			0-0.30				0-0.50			
	3	78.00-84.00	0-0.25	16.00-22.00				0-1.0				0-0.50			
	4	87.50		11.00				0.10		1.50					
High Lead, Tin Bronze	1	80.00-83.00	0-3.00	7.00-10.00	7.00-10.00	0.25M	0.03M	0.05M	0.50M	0.25M	0.08M				Alloy 1 is used for heavy-pressure bearings, and for wear-resistance. Alloy 2 is used for high-speed, lower-load bearings; for railroad bearings and liners; and for roll-neck bearings. Alloy 4 is used as metallic packing in engine and compressor piston rods and valve stems.
	2	73.00-78.00	0.50M	5.00-10.00	15.00-20.00	0.25M	0.03M	0.05M	1.00M	0.50M	0.08M				
	3	63.00-75.00	0.50M	0-5.00	25.00-35.00										
	4	40.00-60.00			40.00-60.00										
Aluminum Bronze	1	86.0M		0.5M		2.5-4.0							8.0-9.50		Alloys 1 and 2 (as-cast) are resistant to food acids. Used for gears, especially when mated with hardened steel gear. Also used for steel mill stripper nuts, etc.
	2	88.25-90.5		0.2M		1.25M							9.5-10.5		

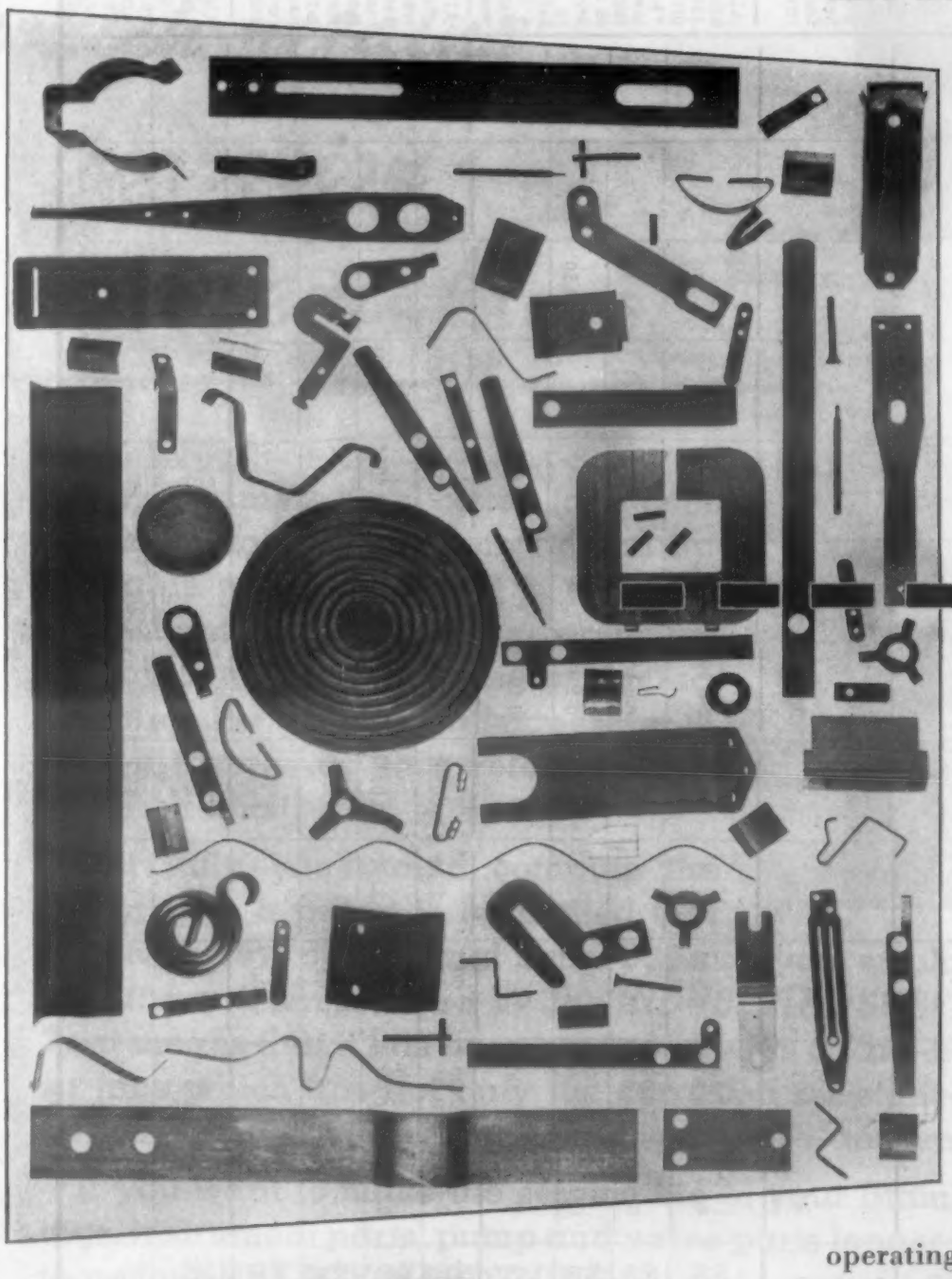
Compiled by N. F. Hindle, Asst. Secretary, American Foundrymen's Association

This table also appears in the book "Handbook on Designing for Quantity Production", by Herbert Chase.

"Micro-Processed" Beryllium Copper

FLAT SPRINGS

Hold Proper Shape Indefinitely!



Micro-processing starts with the premise that if you know the characteristics of the beryllium copper strip you are using, know the physical and electrical requirements of the finished spring . . . then the variables of time-temperature involved in heat treat forming can be controlled within the closest of limits.

Flat springs with exceptionally long service life and original accuracy are the inevitable result.

Thus, Instrument Specialties delivers in any desired quantity (from one spring to millions) flat springs Micro-processed to the following tolerances:

Angles: Within ± 1° on bends.
Flatness: Within .001 to .003 in. per inch of length.

Simple or complex designs are equally responsive to Micro-processing; maximum desired properties are also easily attainable. As an example: springs heat treated for minimum drift have unusually high endurance strength. With the Carson Electronic Micrometer developed by I-S, it is a routine matter to measure drift in pilot lots and predict repetition of results in production quantities.

Great savings are possible by incorporating Micro-processed Beryllium copper flat springs in your equipment . . . assembly and maintenance cost is lowered, higher operating efficiency is obtained, and absolute uniformity of characteristics is assured.

Make use of our sample spring and engineering design departments — send drawings, samples, or specifications. We stand ready to prove our statement — on your own springs.

"Making Beryllium Copper Behave"
The story behind the development of micro-processing.

"Spiking A Rumor"
The facts about the greatly increased supply of beryllium copper.

"Predicting Spring Performance of Beryllium Copper Wire & Strip"
Why beryllium copper varies in hardening response and what to do about it.

INSTRUMENT SPECIALTIES CO., INC.

224 BERGEN BLVD. • LITTLE FALLS, N. J.

Field Engineering Offices: Boston - Chicago - Cleveland - Philadelphia - New York

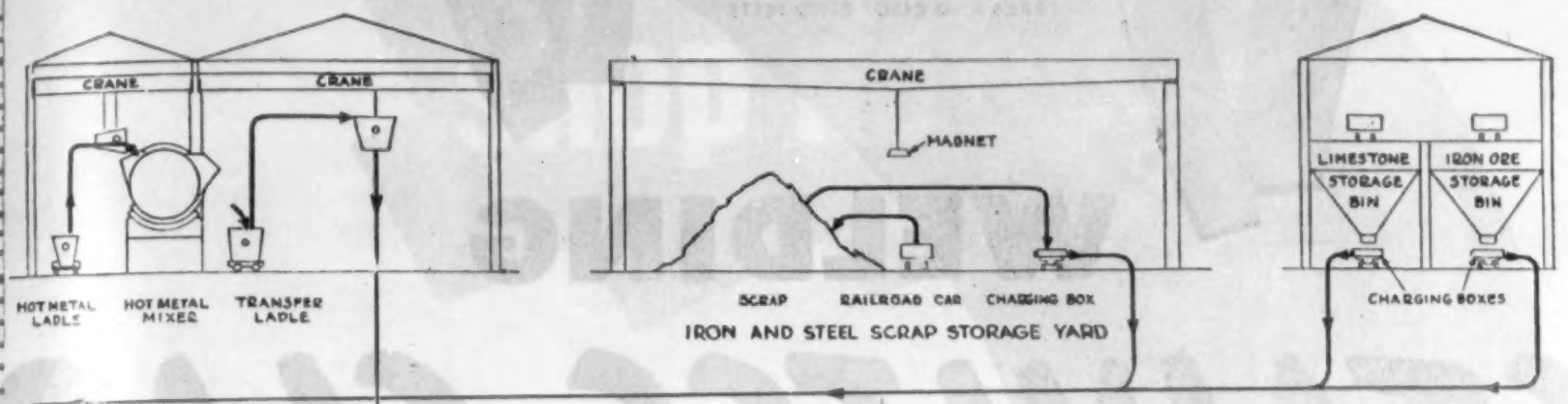
METALS and ALLOYS

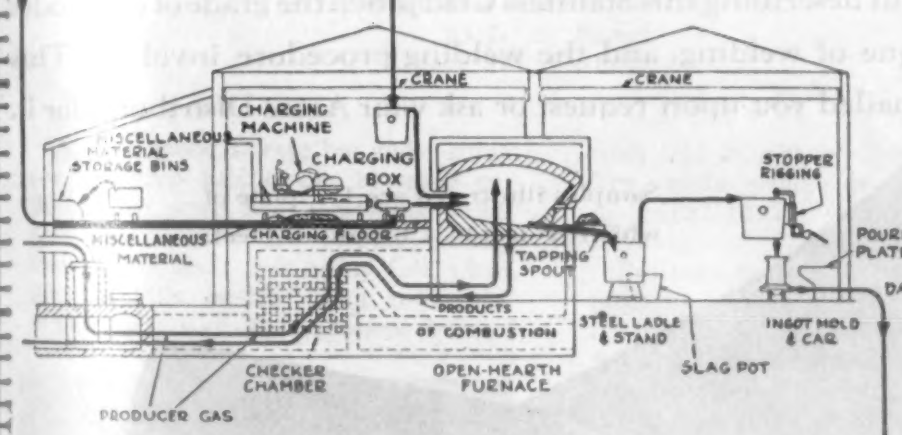
Engineering File Facts

NUMBER 48
May, 1944

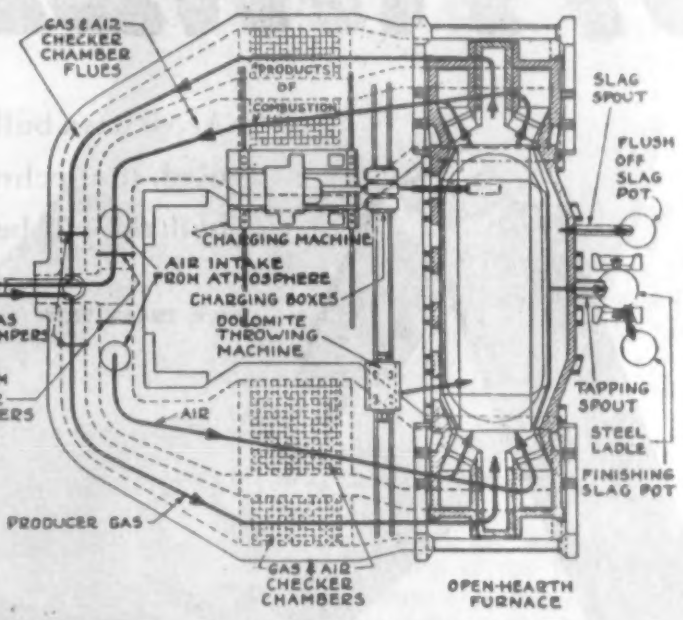
PROCESSES AND PROCEDURES
Steelmaking

The Open Hearth Steel-Making Process

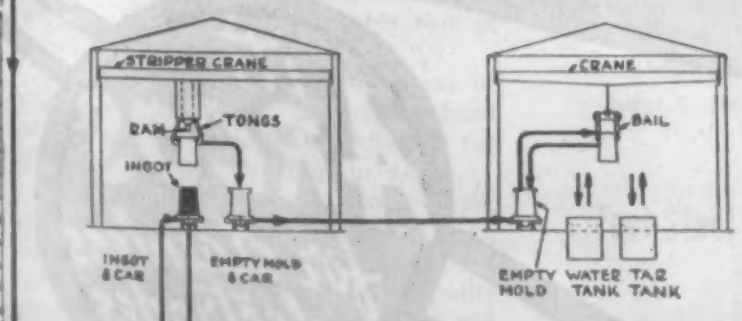


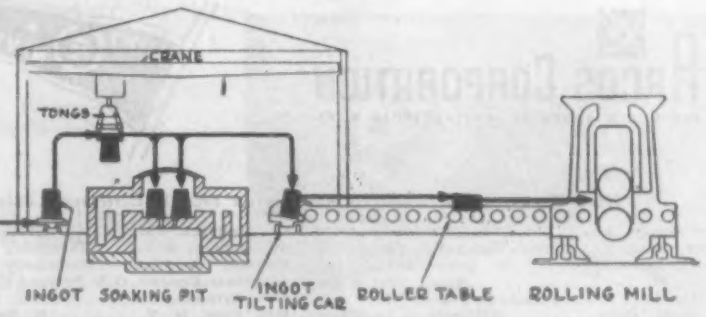


CROSS SECTION OF OPEN-HEARTH FURNACE
BURNING PRODUCER GAS



PLAN OF OPEN-HEARTH FURNACE
BURNING PRODUCER GAS





Copyright by Earl E. Moore

Originally published in "US Steel News"

WELDING STAINLESS CLAD

Arcos has a bulletin describing this Stainless Clad job...the grade of electrodes used, the technique of welding, and the welding procedure involved. This bulletin will be mailed you upon request or ask your Arcos Distributor for it.

Samples illustrated are 1¼" plate of which ¼" is 13% Chromium Steel.

ARCOS CORPORATION
401 NORTH BROAD ST., PHILADELPHIA 8, PA.

ARMY (E) NAVY

Distributors Warehouse Stocks in the Following Cities:

Baton Rouge, La.....Wm. D. Seymour Co.	Los Angeles, Calif.....Victor Equipment Co.
Borger, Texas.....Hart Industrial Supply Co.	Milwaukee, Wis. ...Machinery & Welder Corp.
Boston, Mass.....H. Boker & Co., Inc.	Moline, Ill. .....Machinery & Welder Corp.
Buffalo, N. Y.....Root, Neal & Co.	Montreal, Canada. G.D. Peters & Co. of Canada, Ltd.
Chicago, Ill.....Machinery & Welder Corp.	New Orleans, La.....Wm. D. Seymour Co.
Cincinnati, Ohio.....Williams & Co., Inc.	New York, N. Y.....H. Boker & Co., Inc.
Cleveland, Ohio .....Williams & Co., Inc.	Oklahoma City, Okla..Hart Industrial Supply Co.
Columbus, Ohio .....Williams & Co., Inc.	Pampa, Texas.....Hart Industrial Supply Co.
Detroit, Michigan....C. E. Philips & Co., Inc.	Pittsburgh, Pa.....Williams & Co., Inc.
Erie, Penna. .....Boyd Welding Co.	Portland, Ore.....J. E. Haseltine & Co.
Fresno, Calif.....Victor Equipment Co.	Rochester, N. Y.....Welding Supply Co.
Ft. Wayne, Ind..Wayne Welding Sup. Co., Inc.	San Diego, Calif.....Victor Equipment Co.
Honolulu, Hawaii..Hawaiian Gas Products, Ltd.	San Francisco, Calif.....Victor Equipment Co.
Houston, Texas..Champion Rivet Co. of Texas	Seattle, Wash.....J. E. Haseltine & Co.
Kansas City, Mo..Welders Supply & Repair Co.	St. Louis, Mo. .....Machinery & Welder Corp.
Kingsport, Tenn.....Slip-Not Belting Corp.	Syracuse, N. Y.....Welding Supply Co.
	Wichita, Kansas .....Watkins, Inc.

it's ARCOS for stainless electrodes

"QUALITY WELD METAL EASILY DEPOSITED"

METALLURGICAL ENGINEERING

shop notes

Home-Made Babbitt Melting Pot

by G. C. Becker,
Linde Air Products Co.

A combination storage bin and melting pot for scrap babbitt can be made entirely from scrap and a welding outfit. Scraps of babbitt are thrown directly into the pot until it is nearly full, when the metal is melted down over convenient heat such as a kerosene burner.

The pot can be made from a 20-in. length of 14-in. scrap pipe or pieces of ⅜-in. steel plate, with ½-in. plate welded into a bottom, the fabricated receptacle being in shape and size roughly that of the ordinary ash can.

The spout is made from a section of 3-in. pipe, triangular in profile, fitted to the pot by making a U-shaped cut from the rim and welding in place.

Trunnions, for the pot to tilt on, are made from two 4-in. lengths of 1-in. round stock, welded perpendicular to the pot wall and positioned on opposite sides at points 90° from the spout and 12 in. from the bottom.

A handle for tipping is from rod stock, shaped in a semicircle and welded near the bottom, opposite the spout. A little refinement is a spill guard, a plate 4 in. wide, welded inside the top of the spout.

The next job is to form the cradle from odd lengths of 2½-in. scrap pipe. The cradle should be made about 20 in. high, 22 in. wide and 4 to 4½ ft. long.

Bearings to support the trunnions are made by halving a 3-in. section of 1¼-in. pipe with the cutting blowpipe, then welding one-half to each side of the frame on top of the center uprights, lining up these two pieces accurately.

Though this idea was originated in aircraft plants, there are hundreds of other industries where it can be adopted. On dollies, which carry airplane wings along the assembly, bins have been installed to that materials used in fabrication, such as rivets, hammers, etc., can travel with the wings. Previously, workers went to bins some distance away to get materials. By the new method, 360 man-hours a week were saved.

—James G. Heiman & Cecil A. Westmoreland, Curtiss-Wright Corp.

Tool Steel Tubing for Round Dies

by Carl Richter
Bissett Steel Co.

Often when dies of circular pattern were made, one started with a solid bar, boring it out to make a simple tubular part. Suppose a tool steel bar, 6 in. in diam. and 1 ft. long, is bored into a tube with 1-in. wall thickness. Then the equivalent of a 4-in. bar is simply swept up as scrap. If the steel costs 40c per lb., the waste in material alone is over $17.

During this war tool steel tubing has been used for blanking and forming dies, punches, collets, collet closers, spindle thrust collars, lead screw thrust collars, rim rolls, hardened rolls, master tools, ring gages, bushings, slitters, spacers, skiving knives, machine tool parts, and many other tools and parts.

The die shown in the photograph, for instance, is made of four different sizes of tool steel tubing. In the portion of the die shown at the left, the outside section of tubing is the blanking ring, the middle section is the pressure pad, and the inner section is the draw stake.

In the portion of the die shown at the left, one section of tubing was used to make a blanking and drawing ring. Sizes of tubing in this die range from 14 in. to 10 in. O.D. The die blanks and forms small heater tops out of 20-gage cold rolled sheet in a single operation.

If tool steel tubing had not been used, the die would have been made by forging rings to size and then machining them. In smaller dies, particularly with a deep draw, the only other method would be to bore solid bars.

Reclaiming "Unused" Tools

by Oscar W. Cooper,
Yale & Towne Mfg. Co.

By now it has become quite common throughout the metal working industry to reclaim and salvage used tools, such as by torch brazing cutting surfaces with cemented carbide tips. But it is perhaps rare to reclaim "unused" tools — yet that is what is being done at the Yale & Towne plant.

It all started when carbide tipped tools proved so satisfactory that it was difficult to get workmen to use up the old high-speed steel and carbon steel tools still in stock. So we decided to carbide tip all the tools.

We justified our action by considering all unused tools as merely blanks made for the individual jobs, and to be placed in final working condition.

A shop to make such a change must have adequate grinding facilities. Our greatest success has been with pull-type broaches, and we have covered rectangular and square shapes; also, keyways in cast iron, steel and bronze.

Procedure is to grind a tip seat in front of the broach tooth and split up the cutting surface so that chip breakers are provided. The only teeth having a full surface would be the last two or three finishing teeth.

Where sides and bottom of the slot are broached, we finish the sides with a portion of the broach before starting the finishing cut on the bottom.

As to keyway broaches, one grinds out a section of the steel cutting teeth and inserts a carbide strip in which the cutting teeth may be ground out of the solid material. As to large rectangular broaches, we get a first run from the high-speed broaches and then proceed with the tipping.

Our cutters range from Tee cutters, as small as ½-in. in diam. by 3/32 in. thick, to inserted tooth cutters up to 15 in. in diam. — and we tip all, the procedure being similar to broaches.

For inserted tooth cutters, tips are applied and roughed out before placing in the cutter body for finish grind. The usual "hook angle" can be modified to produce better results when needed.

When tipping counterbores, one holds the tips slightly outside the pilot hole diameter so that the carbide tip does not need to be internally ground.

With hollowmills, the tips should protrude slightly into the hole so that they will be internally ground to produce the necessary inside cutting edge. One inserts a carbon plug in the hole with a reduced diameter against which the tips can be located when silver soldering.

With circular form tools, one grinds three tip recesses, inserting carbide tips, and finish grinding to the correct form from the solid tip. For short run jobs, one gashes the circular tool and brazes the tip to the proper height, when the form may be ground in the surface grinder. Sometimes a slight side relief enhances the cutting quality.

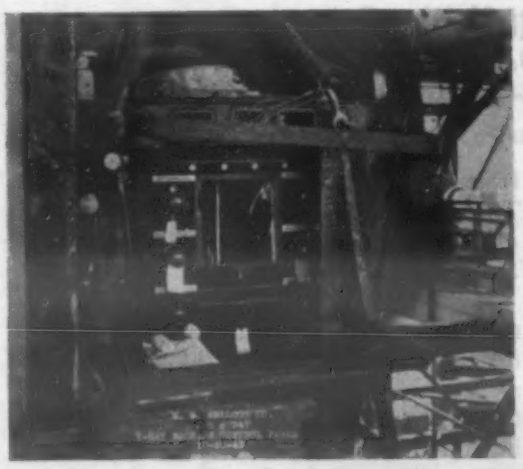
Sometimes we change the design from a circular to a dovetail style tool on automatic screw machine work. When impractical to grind from the solid, a formed tip is purchased, thus reducing grinding time. Flat form tools for lathe and hand screw machine work may be treated in the same way.

With reamers, one grinds tip recesses, brazing in the carbide tips, then finish grinding to size. Where feasible, every other tooth is tipped for economy and required chip clearance.

Skyscraper X-Ray Examination of Welds

by Earl J. Winter,
Kelley-Koett Mfg. Co.

The X-raying of welds as high as 250 ft. in the air on a construction job naturally presented some novel problems. Apparatus was hoisted from level to level



by crane as the work progressed. The job was the construction of a fluid catalyst cracking unit at the Standard Oil Co. of New Jersey's refinery in Baltimore.

Construction engineers of the M. W. Kellogg Co., general contractors and engineers, were asked to X-ray all welds in the huge plant. Technical experts of the Kelley-Koett Co., working with the Standard Oil Development Co. and the Kellogg organization, "stripped down" a standard 220,000-v. X-ray unit. The unit was fitted to a special rigging that allowed for its being hoisted by crane.

Despite rainstorms and unavoidable jars and jolts, the testing of welds in awkward locations went forward successfully. This may prove the forerunner of many post-war applications in shipbuilding, plant construction and other heavy industry uses.

In the accompanying photograph is seen the X-ray control panel hanging at one of the skyscraper levels. When air hammer and other construction noises were too great, the doubly insulated telephone was discarded in favor of colored signal lights for communication with operators at the tube head.

Transformers, etc. are stripped of protective covers to reduce weight, the only protection being a tarpaulin.

There are certain times when die-quenching has advantages over liquid-quenching, an instance being hollow airplane propeller blades of nickel-chromium-molybdenum steel, SAE 4330. The spread between the temperature at which this steel is normally removed from the heat-treating furnace and the temperature at which it hardens provides for ample time for placing in dies that prevent warpage. Were liquid-quenching used, there would usually be warpage, straightening by hammering when cold and possible breakage.

—"Inco,"
International Nickel Co., Inc.

Drawing of Procedure Charts

by Willard Lund

Whereas it formerly required three days to train one operator in electronic brazing, now a single day only is needed to train two operators by our drawing procedure charts. These charts quickly teach the intricacies of silver soldering delicate pieces of jewelry, welding and brazing of lamp and tube parts, industrial glass blowing, winding of tiny filaments and tie wires, and many other such intricate operations.

In one instance at the Westinghouse Lamp Div. plant, the charts reduced rejections approximately 25%. An important feature of our drawings is that the artists themselves master the technique involved before they touch a pencil.

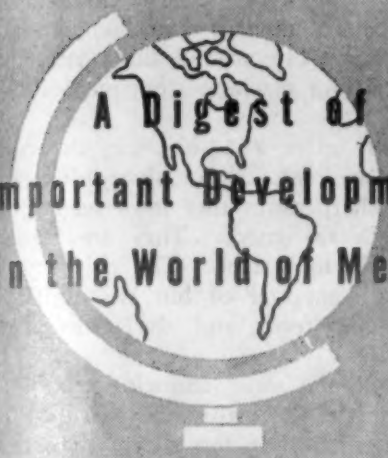
When a girl operator is absent, an outsider is brought in, given a chart, and she quickly learns the new routine.

Before entering his present profession, the author was a correspondence school crafts instructor and illustrator. Having been compelled to get his ideas across

by mail, he perhaps acquired some knack for industrial plant training.

In the accompanying photograph the author is preparing one of these charts.

Metallurgical Engineering Digest



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1 Metal Production

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Magnesium Powder Fabrication

Condensed from "Light Metal Age"

Magnesium powder is an important munition for flares, incendiaries, etc. It is chemically pure magnesium, 99.98% or more pure. Its fabrication into powder of the correct fineness is considerable of a technique, and fraught with more problems than might appear on the surface, one of the main problems being to guard against fires while in process.

There are many fabrication processes, but the one herein described may be termed the "hammer-mill" method, to distinguish it from the ball mill type, which is full of hazards. The raw material is received in the form of extruded rods or bars in lengths ranging from 30 in. to 12 ft., with diameter 1.3 in.

The rod first goes to the chipping machine, which receives rods just 28.8 in. long; hence, raw material must be sawed into these lengths before charging. "Chipping," a reverse form of milling, consists of using cutters to chip or shred slivers from the end of the rod.

The rods are mounted into a carriage that feeds them to the cutter at a speed synchronized so that the rods are moved forward from 1/16 to 1/32 in., corresponding with the desired thickness of the chip. Five rods are mounted into the machine at a time, or about 12½ lbs. of magnesium per charge.

The cutter, mounted on a mandrel, is equipped with helical cutting edges, along the edges of which saw-like points are spaced. With each rotation of the cutter one cutting edge gouges out 14 chips per rod. Usually four such machines comprise a battery.

Out of every 12 ft. charged, 2/3 ft. remains in the machine as a stub or butt, hence waste. There is other waste in the form of stringers, porous extrusions, split rods, etc.

The chips are fine light ribbons, usually appearing singly but sometimes twined, resembling wood shavings, and are slightly over 1 in. long. Chips do not always break completely off into the theoretical lengths. However, the regulation chips make better powder, and sometimes the long chips wrap around the cutter, sometimes causing machine stoppage for cleaning.

Usually after a 12-hr. run, the cutters have to be removed for sharpening. After several sharpenings they must be reground and teeth realigned. They are made of high-grade tool steel. The chipping machine is composed of but two units: the carriage or feed, and the mandrel and cutter.

One of the most annoying troubles at times is "chatter," which is caused by tools either too dull or too sharp, the remedy being to change the cutters.

Chips are removed constantly by a blower and conducted to a separate building 10 ft. distant, as the more segregated magnesium is, the safer. It is conducted through a copper tube to avoid static charges and sparks. Further steps of milling and classification of powders are being described in subsequent articles.

—*Light Metal Age*, Vol. 2, No. 1, Jan. 1944, pp. 10-13.

Scrap in Electric Furnace Steel

Condensed from "Steel"

A successful procedure for using more alloy steel scrap in electric furnaces is described. Foundries with small electric furnace units have objected to using additional alloy scrap. Melting of these turnings imposed considerable hardship and chance because of bulk, erratic composition, and retained cutting oils.

Experiments were conducted with charges containing more than 85% alloy steel scrap. Some carbon steel scrap is required to adjust chemical composition, as no virgin alloy is added. A specific range that meets all physical requirements can be maintained by following charging instructions.

The range of the elements and the percentage of the "withins" for each major element are respectively: Carbon, 0.27 to 0.37, 93%; manganese, 0.75 to 0.85, 92%; nickel, 0.60 to 0.90, 67%; chromium, 0.40 to 0.60, 98%; and molybdenum, 0.17 to 0.27, 95%.

Nickel is the hardest element to control, as there is a variation of as much as 0.30%

Below—the completed Ramix hearth. Note the smooth, well-shaped contour of back wall, front wall, port slopes and uptakes. At left—the furnace before Ramix was installed. Right, below—forms in place for ramming in the flat.

RAMIX helps make Steel for Victory

This is one of a battery of eleven new 225-ton open hearth furnaces completed in 1943. All have hearths constructed of Ramix.

Ramix is a unique refractory material that is cold-rammed in place to form the furnace bottom and banks, on which steel is melted and refined. As it is a high-magnesia-type refractory, reinforced with chemical bonds, Ramix is not affected by the high temperatures met in the open hearth furnace, and unlike most magnesia refractories is NON-HYDRATING.

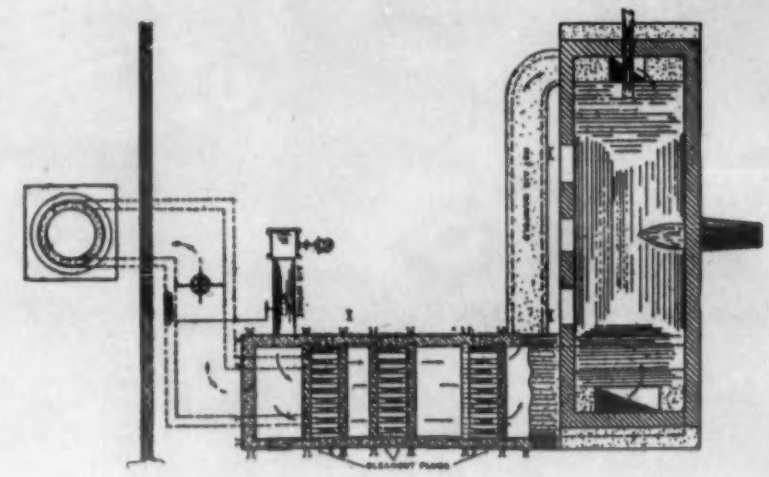
Not only does every Ramix hearth installed save several days of construction—making possible 10 to 15 additional heats of steel in the time saved, Ramix also makes a clean, slag-resistant bottom that requires a minimum of maintenance and repair. Delay time is reduced, furnace output per manhour is increased, steel poured is cleaner, and quality better.

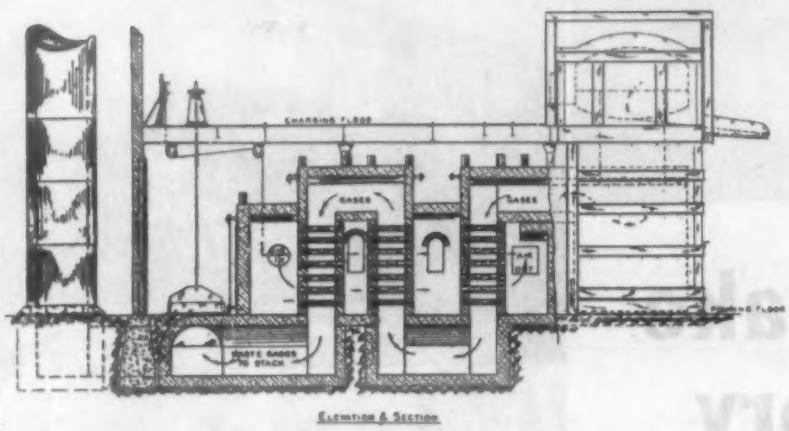
Steel is being made on Ramix bottoms in more than a hundred open hearths today. They represent better than 12% of the basic open hearth steel capacity of America. They range in size from small 20-ton jobs in steel foundries to the largest furnaces yet built. They are located in every important steel producing center.

Experienced Basic Refractories Engineers are at the service of the steel industry to supervise the installation of Ramix bottoms. Let us know when there is a hearth job to be done.

BASIC REFRACTORIES, INCORPORATED *Cleveland 15, Ohio*

"FITCH" RECUPERATORS
For OPEN HEARTH





The maximum production of a furnace is made possible by continuous firing in one direction. The life of the "Fitch" recuperator is prolonged over an indefinite period of time by the ability to replace individual parts without disturbing the balance of the structure. The first cost of the recuperator is no greater than the cost of the conventional regenerators and reversing valve equipment.

WHY REVERSE?

WE DO NOT BUILD FURNACES

Write for Bulletin No. 12

"FITCH" RECUPERATORS for the STEEL INDUSTRY

FITCH RECUPERATOR CO.

PLAINFIELD NATIONAL BANK BUILDING. PLAINFIELD, NEW JERSEY

of this element in scrap steels purchased under the same specifications. Other elements maintain a much narrower range.

Sampling is important in maintaining proper scrap piles and charges. When cars contain only one type of scrap, two samples are selected and analyses run in duplicate on each. When a car contains several types of scrap, two samples of each type are analyzed in duplicate and the entire lot is averaged. Scrap is then grouped according to the average composition.

Scrap is charged by magnet into charge buckets, according to instructions issued by the laboratory. The instructions vary according to composition of scrap, and the quantity of foundry alloy remelt to be consumed.

A typical charge consists of 4000 lb. foundry alloy remelt scrap, 1000 lb. "moly" plate (purchased) scrap, 4000 lb. SAE 4340 (purchased) scrap, 1000 lb. NE 8600 (purchased) scrap, and 2000 lb. carbon (purchased) scrap.

This type of melting has produced a steel that meets requirements of all 4B series and 4C1 to 4C3 of Federal specification QQ-S-68 lb., consistently and regularly, by varying heat treatment according to the physical properties desired. A fairly close control of physical properties can be obtained by controlling Brinell hardness.

Advantages of this type of melting include economy in conserving alloying elements, decreased melting time and power consumption, easier operation, and more consistent results from less experienced melters.

These tests indicate that 30 to 40% of purchased alloy scrap can be melted in addition to foundry returns, depending upon alloy specification and composition of available scrap.

—Victor E. Zang. *Steel*, Vol. 114, Feb. 21, 1944, pp. 88, 110.

Copper Smelting in 1943

Condensed from "Engineering and Mining Journal"

Copper smelters were kept so busy producing at maximum rate that they had little chance to improve practice. But the American Smelting & Refining Co. was able to increase the copper-lead ratio of both speiss and matte in handling copper in lead plants by a soda ash treatment in smelting the lead drosses.

This eliminates the formation of all slags, and is well suited for lead plants, where little speiss is formed and the copper content of the charge is high. The increase in the grade of copper concentrates has made direct-smelting more attractive.

At Hudson Bay's Flin Flon plant the tonnage of pay charge treated and the amount of copper produced will be higher than for any previous year. Besides handling all available tonnage of concentrates through the roasters and reverberatory furnace, selected high-grade ore from the mine was smelted direct in the converters.

A tunnel was blasted out alongside the furnace and a track installed, so that a

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuck-stones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED

A BETTER REFRACTORY—

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

Corhart Refractories Company, *Incorporated,* Sixteenth and Lee Streets, Louisville 10, Kentucky.

"Corhart" is a trade-mark, registered U. S. Patent Office.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

This

LIGHTWEIGHT INSULATING BRICK

does "Double Duty"

in Furnace Walls

CONVENIENT 13½ x 9" SIZE — EASY TO HANDLE

REDUCES WALL JOINTS 65%

Other forms of THERM-O-FLAKE INSULATION

Coating — Seals and Insulates all types of furnace walls. Highly plastic, works and spreads easily.

Blocks — Highly efficient insulation where larger size units may be required.

Concrete — Monolithic castable insulation with high insulating value.

Granules — Loose-fill, efficient insulation, weighs only 6 pounds per cubic foot.

Protects furnace steelwork and plating from excessive heat with a strong resilient cushion which absorbs expansion stresses.

KEEPS HEAT INSIDE FURNACE WALLS

Excellent insulation,— a 4½ inch thickness being equivalent in heat flow resistance to more than 29 inches of fire brick.

Find out how quickly THERM-O-FLAKE Brick will pay back their cost in reduced furnace heat losses. For specific data, indicate type of furnace and approx. operating temperatures in writing to:

Illinois Clay Products Company
JOLIET, ILLINOIS

Therm-O-flake BRICK

FOR HOT FACE TEMPERATURES UP TO 2000° F.

ladle could be run close to the tapholes for tapping the matte. By installing suitable hoods and a 38,000 c.f.m. ventilating fan, matte-tapping has been made gas-free.

To conserve heat in the roaster gases for efficient operation of the Cottrell plant and to lessen the chances for corrosion, the new steel roaster flue has been fitted with about one in. of plastic insulation. A screw conveyor has been installed under the flue to remove the dust to a hopper, from which it is hauled to the furnace in cars.

During the year a "black copper" program went into effect to augment the supply. Smelters purchased copper-base scrap on a copper content basis and smelted it to black copper and sometimes blister for the account of Metals Reserve Co.

Data was gathered and made public on how to recover copper from clad-steel scrap, the methods being: Direct melting, molten lead-bath treatment, electrochemical processes, scaling, sulphide scaling, ammonium sulphate leaching and cupric ammonium carbonate leaching.

An important contribution was that of F. W. Willard (METALS AND ALLOYS, April 1943, pp. 752-759) for the recovery of copper from copper-base scrap, with techniques differing, depending on the percentage of contained copper, ranging downward from 99 to 5% Cu.

—Ettore A. Peretti. *Engrg. & Mining J.*, Vol. 145, Feb. 1944, pp. 98-99.

Rolling Metal Propeller Blades

Condensed from "Automotive and Aviation Industries"

A modern development of propeller manufacture is the use of an automatic rolling mill for taper rolling the thrust and camber steel plates to greater precision and with a saving of material and manpower. Only one man is necessary to operate this automatic mill and loader.

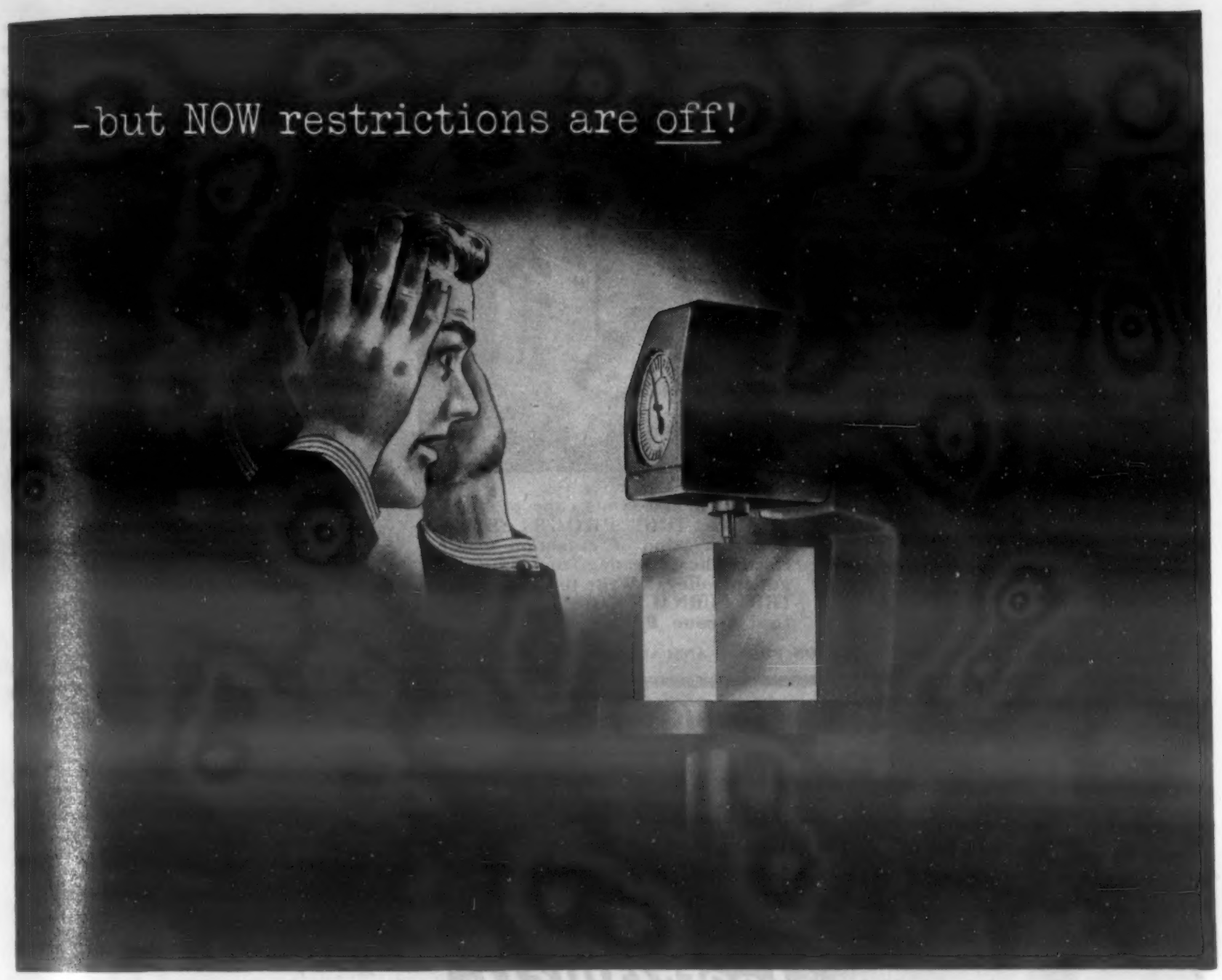
Steel skelp plates can be rolled for blades up to 144 in. long, at the same time rolling in them the bridge walls required to permit efficient metal distribution.

This mill rolled 400 skelp plates to demonstrate that short, one-half length plates could be taper rolled to required specification to eliminate slab milling, saving $200,000 per month in waste material. The mill was a 45-ton automatic with pressure loading up to two million lb., its power in rolling fluctuating from 100 to 400 hp. Rolling time was 12 sec. for three passes per plate.

To do the job, an automatic progressive heating furnace with a speed of 80 billets per hr. was used. The temperature at the tip, where excessive rolling takes place, was 2100 F. At the point where rolling was slight, it was 1450 F.

The billet was 1 in. thick by 22 in. long for a multiple pass automatic mill and 0.50 in. thick at the tip, with the entire airfoil zone rolled to tolerance ± .002 in., eliminating machining. Skelp of this size with bridge wall requires only two passes and a rolling time of 8 sec.

The mill is designed so that it will re-

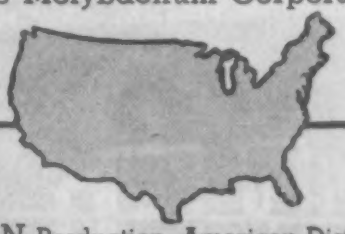


Five points more of

MOLYBDENUM *would have done it!*

Often, while the use of Molybdenum was restricted by Government order, it was hard to get the required physical properties in high-grade steels. And in many troublesome cases, as little as five points more of Molybdenum would have assured success.

There is now no such difficulty. Since the beginning of the year, restrictions are off. There is Molybdenum for all uses. It is necessary only to know what percentage of Molybdenum will give the best result, and to employ that percentage. Inquiries concerning any use of Molybdenum, Tungsten, or Boron will be welcomed by the Molybdenum Corporation.



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MOLYBDENUM CORPORATION OF AMERICA

GRANT BUILDING, PITTSBURGH, PA.

MCA

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:**

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS," the news magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia 23, Pa.

***UPWARDS OF 5 BILLION POUNDS ANNUALLY**

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

50 ton "KT" Lectromelt ready for charging

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

peat any number of passes with precision registration at a predetermined reduction with the proper metal distribution. To form a bridge wall, the longitudinal die is used to force metal into a deep groove of the roller.

The roller and longitudinal die combination will produce any blade shape possible with the two-roller setup, and excels in all forms of precision cavity rolling.

Skelps for hollow steel propeller blades of various sizes and construction can be rolled on this mill. Solid and tubular aluminum alloy blades also have been rolled at mass production speed. Precision rolling eliminates the common practice of machining the airfoil zone to secure gage thickness.

—J. W. Smith. *Automotive & Aviation Inds.*, Vol. 90, Feb. 15, 1944, pp. 22-24, 170.

Blast Furnace Moisture Control

Condensed from "Iron and Steel Engineer"

A study was made on the No. 4 blast furnace of the Corrigan-McKinney plant to determine the influence upon the furnace operation and pig iron analyses of maintenance of uniform blast moisture.

To establish the performance on natural air, furnace and atmospheric data were obtained for test period I, when hourly wet and dry bulb temperature readings showed the moisture content of air to the furnace, while operating with natural, uncontrolled moisture, to vary from 0.65 to 3.55 grains per cu. ft., with variations of almost two grains per cu. ft. within 24 hr.

Provision was made for injecting steam to the cold blast line near the blower discharge to correct hourly for variations in natural moisture until a total moisture of four grains per cu. ft. was maintained. During the tests no changes were made in furnace practices to compensate for the additional moisture in the blast.

The total moisture level was gradually increased to six grains per cu. ft. during test period II. At the conclusion of the second test period, a comparison was made between the operating results of the controlled and natural moisture periods.

The most pronounced change was in th frequency of the casts having higher that desirable percentage of silicon in the iron. During the test period with natural moisture, 22.6% of the casts had 1.15% or more silicon in the iron, although the desired silicon range was from 0.65 to 0.95%.

During period II, with moisture controlled, 4.5% of the casts had more than 1.15% Si in the iron. The per cent silicon in the iron was evidently decreased by the control of the blast moisture, because 49.7% of the casts were within the desired range of 0.65 to 0.95% Si, compared to approximately 35% during uncontrolled moisture tests.

Moisture Content Raised

Steam was next injected to control total moisture at six grains per cu. ft. During

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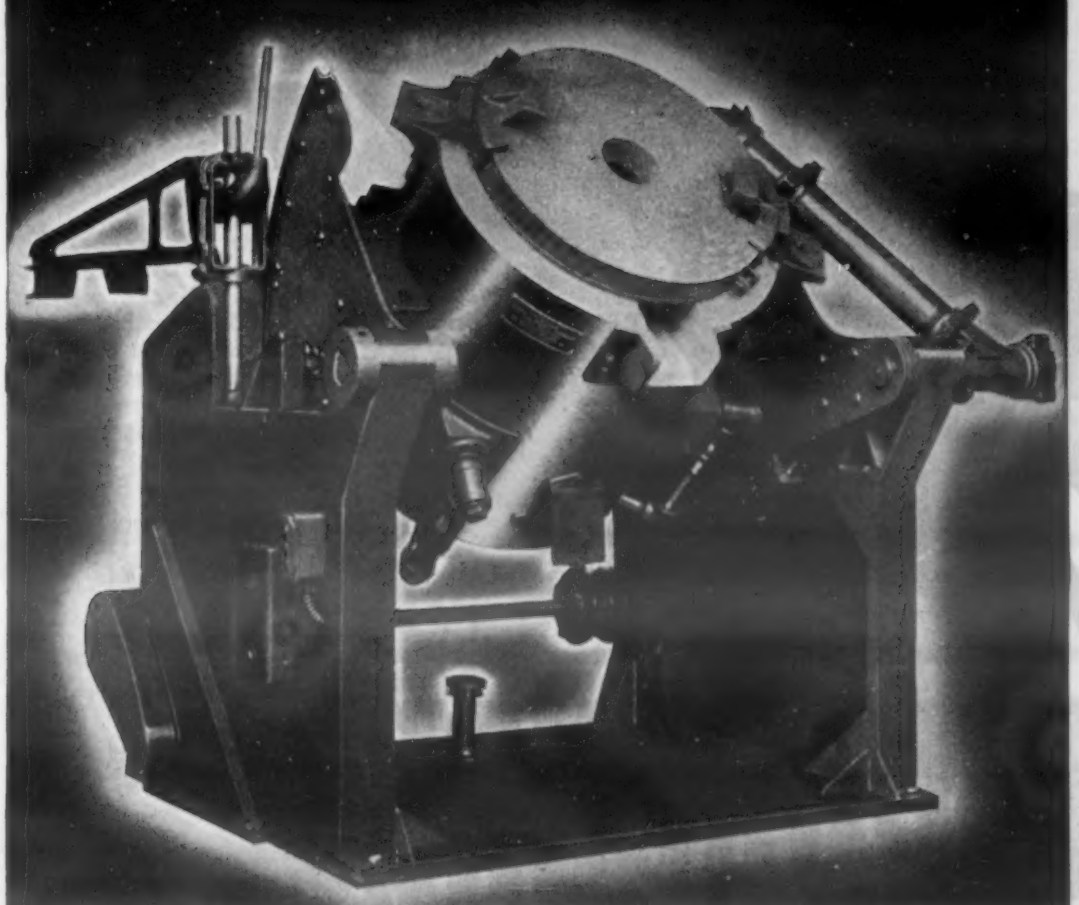

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this time, the natural moisture was extremely variable, with changes from 0.6 to 5.2 grains per cu. ft. The summary of silicon in the iron for this period shows that although 13.6% of the casts had more than 1.15% Si, 42.2% were within the desired range of 0.65 to 0.95%.

The total moisture in the blast was next controlled at eight grains per cu. ft. (Test V). During this test, the natural moisture was extremely changeable, ranging from 2.2 to 8.3 grains per cu. ft. Furnace production during this period was 6% lower than during period IV.

However, the iron analysis was considerably better than during any previous test. Only 3.1% of the casts had more than 1.15% Si in the iron, and 68.2% of the casts were within the desired range of 0.65 to 0.95% Si.

There were in all four natural moisture tests and five controlled moisture tests. Normally 18% of the casts have above 1.15% Si, compared to 6% with excessive silicon when moisture is controlled. It is apparent that excessive silicon casts are much more frequent during periods of low natural moisture during the winter than they are during the summer with fairly high natural moisture.

During the uncontrolled moisture tests an average of only 44.1% of the casts had the desired 0.65 to 0.95% Si in the iron. With the moisture controlled, an average of 58.6% had the desired silicon.

There have been no indications that controlled moisture in the blast has any influence upon the sulphur content of the iron.

—J. J. Alexander. *Iron & Steel Engr.*, Vol. 21, Feb. 1944, pp. 38-41.

Pressed Wood Roll Bearings

Condensed from "Stahl und Eisen"

A new material for roll bearings has been developed that consists of layers of red beech wood and artificial resin, which are tightly pressed together. It is said that this material is equal and even superior to other artificial, compressed materials so far used.

The factors for the suitability of the material were found to be the thickness of the layer, the angle between the fibers of the wood and resin in adjacent layers, resin content, composition of resin and magnitude of compression for finishing.

Tests with such bearings in a finishing mill and a blooming mill have shown that their life exceeded that of other bearings of compressed materials; in the blooming mill, a life of 41 weeks was obtained, in the finishing mills an average of 22 weeks.

The thickness of the bushing should be made equal to $(0.25D/100) + 10$ mm. (D = diameter of roll neck), but in bearings with a pressure greater than 250 kg. per sq. cm. (3,556 p.s.i), the thickness should be 10 mm. (0.4 in.) greater. Cooling and lubrication should be ample to reduce maintenance.

—S. Hellmans & E. Rohde. *Stahl u. Eisen*, Vol. 63, Mar. 18, 1943, pp. 209-216.

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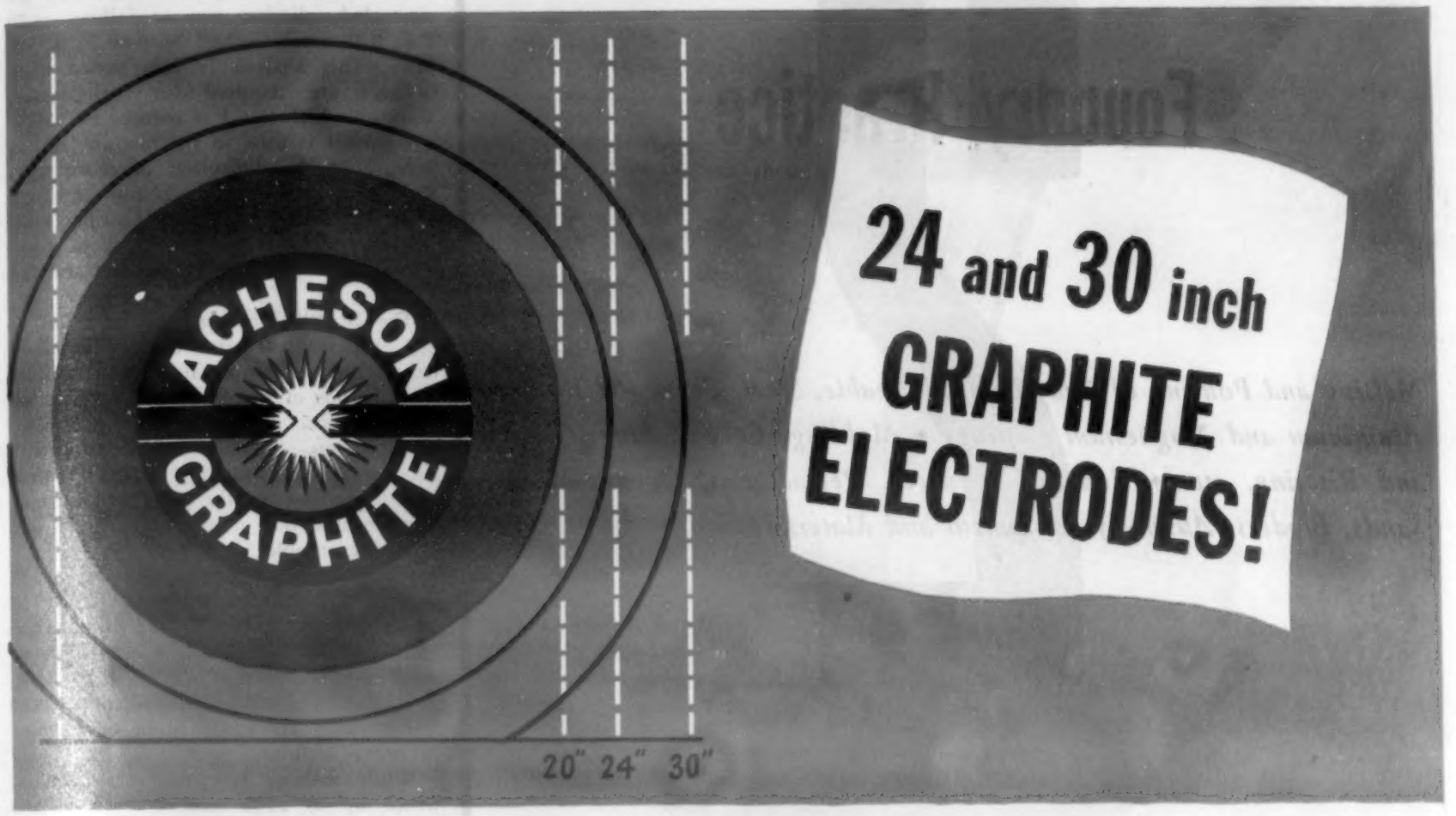

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Production of Air-Cooled Cylinders

Condensed from "Foundry Trade Journal"

The standard analysis of iron used for air-cooled cylinders was as follows: 3.20 T.C, 0.70 comb C, 1.95 Si, 0.60 P, 0.75% Mn. This analysis is only varied when castings are required for high-pressure work, in which case P is reduced to 0.20%.

No steel is used in the mixture, mainly because of the difficulties of obtaining a thoroughly homogeneous mixture under existing operating conditions. Castings made in 0.6% P all show a network of phosphide with a mixture of pearlite and ferrite.

The Brinell hardness runs from 210 to 230, usually taken on the holding-down flange. Metal charges normally consist of three brands of pig-iron, two of which are refined irons, and one a straight blast-furnace iron. This is enough to give a good mix, and should any trouble arise, it is fairly easy, by the process of elimination, to find out at any time which iron is giving trouble.

It is felt that certain irons have hereditary properties that cannot be explained by analysis. Iron is purchased by analysis and fracture. The straight iron is never used in a proportion greater than 25%, and if this figure be exceeded, open grain and porosity are likely to be experienced in heavy sections.

While making heavy-duty cast iron, in which up to 25% steel is used, it was decided to see the effect steel had on ordinary mixtures. These were made up for a period of three months, varying the steel content from 12½ to 25%, and keeping the final analysis the same. It seemed that the straight iron could be increased to 33⅓, with 12½% steel, and still keep heavy sections sound.

Sections of castings are extremely varied; it is now quite common to have thin walls of 5/32 in. thickness, which have to be machined, not ground, running on to heavy sections of ¾ in., and in this latter portion due to the design, the rate of cooling is often very much retarded.

Pattern equipment, coreboxes, sand, cupolas, etc. are also discussed.

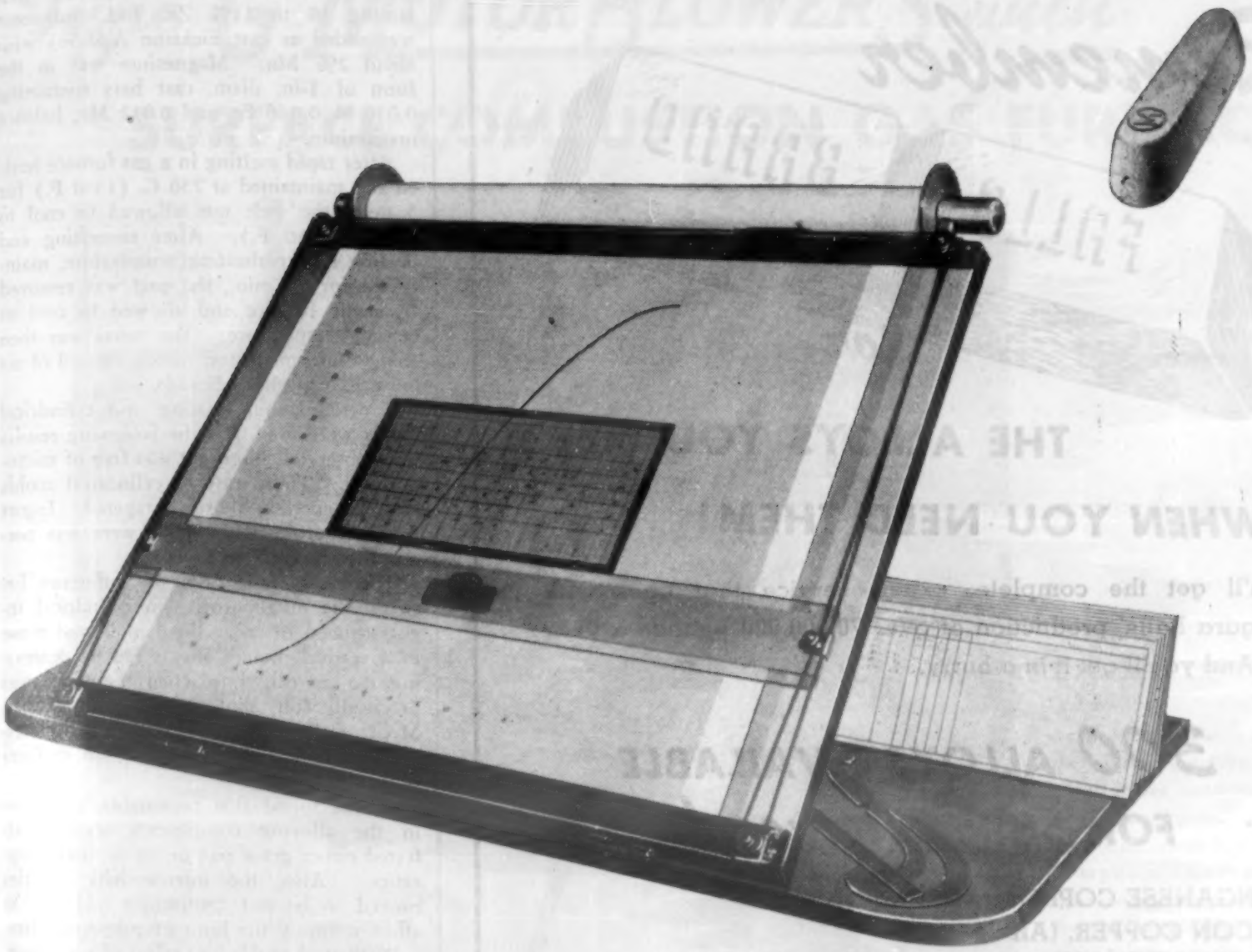
—T. H. Taft. *Foundry Trade J.*, Vol. 71, Nov. 11, 1943, pp. 199-204.

Casting Conditions for Magnesium

Condensed from "The Engineers' Digest"

In an investigation of the effect of casting conditions upon the soundness and properties of a manganese alloy, microporosity (interdendritic cavitation) was found to be the most important problem. The alloy used, 9 to 11 Al, 1.25 max. Zn, and 0.3% max. Mn, has a considerable range of solidification and is, therefore, liable to unsoundness in the casting.

The alloys were cast in two ways, with a melting procedure as identical as possible. The charge of one thousand g. (2.2 lb.) was placed in an iron crucible with about 4% of its weight of Elrasal flux.



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Aluminum and zinc were added in the form of a hardener of aluminum containing 10 to 11% Zn, and manganese was added as cast Elektron A.M.503 with about 2% Mn. Magnesium was in the form of 1-in. diam. cast bars containing 0.026 Si, 0.046 Fe, and 0.012 Mn, balance magnesium.

After rapid melting in a gas furnace heated and maintained at 750 C. (1380 F.) for 5 min., the melt was allowed to cool to 400 C. (750 F.). After re-melting and heating to superheating temperature, maintained for 15 min., the part was removed from the furnace and allowed to cool to casting temperature. The metal was then teemed into mild steel molds, cleared of air by dried sulphur dioxide.

Tapered, group casting and cylindrical molds were used, and the following results were observed: No ingot was free of microporosity. Those cast in cylindrical molds were as good as those in tapered. Ingots produced from a hot mold were less porous than from a cold one.

There was practically no difference between the microporosity in cylindrical ingots teemed in an inclined mold and those in a vertical mold. Ingots fed by decreasing the pouring rate when the mold was practically full, showed less microporosity. Mechanically controlled teeming is necessary to produce ingots with good surfaces by down-running.

It was found that reasonable variations in the alloying constituents scarcely affected either grain size or mechanical properties. Also, the interdendritic cavities proved to be not continuous and not to affect seriously the limit of proportionality.

With steel molds, the effect of superheating temperature upon grain size and mechanical properties is less noticeable than with sand castings.

Solution heat treatment should be carried out for 24 hr. at as high a temperature as possible, followed by quenching in water. Solution is facilitated if the compound is in the eutectic state. A hot mold aids the separation of the beta-constituents as an eutectic structure.

Commercial practice should provide the largest possible proportion of euctectic, and the rate of cooling in the mold should be controlled. Tempering should be done at approximately 185 C. (365 F.) for 24 hr.

Better castings were found to be produced from remelted ingot alloy than from a virgin metal.

—W. R. D. Jones. *Engineers' Digest* (American), Vol. 1, Feb. 1944, p. 164.

Cupola Tapping

Condensed from "Foundry Trade Journal"

The expansion of mass production methods in the foundry industry has stimulated the interest of many foundrymen in the "syphon brick method" of metal distribution. The object of using the syphon brick is primarily to cut out the tapping and bottling-up the cupola tap-hole each time metal is drawn off.

With this system in operation, the presence of a skilled cupola man at the furnace spout is unnecessary, as the orifice

Type "G" MOTOR BLOWERS with

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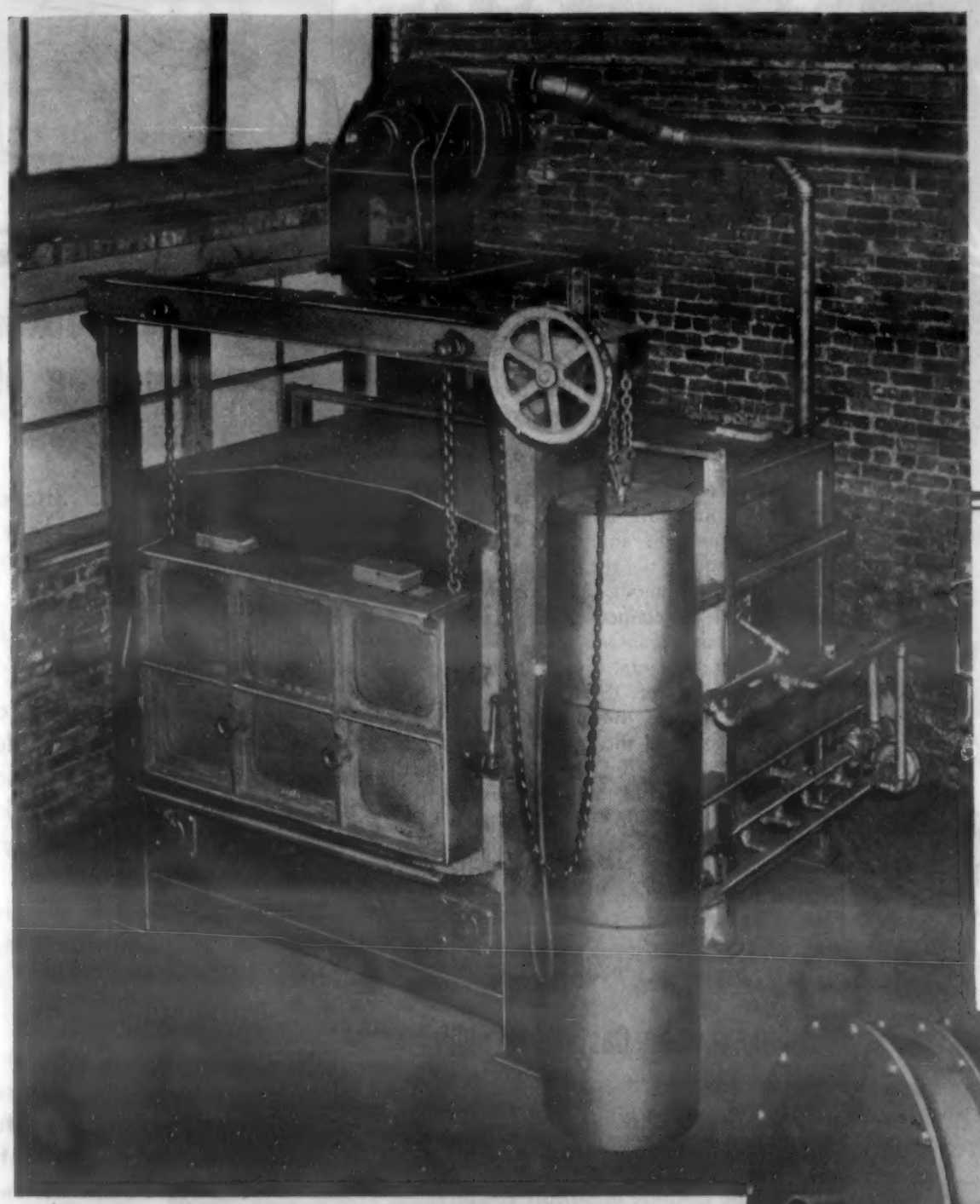

At the left is shown a Surface Combustion gas-fired, oven-type furnace used for heat-treating and annealing in an Illinois malleable iron casting company. The Type "G" blower mounted atop the furnace supplies air to two other furnaces in the plant.

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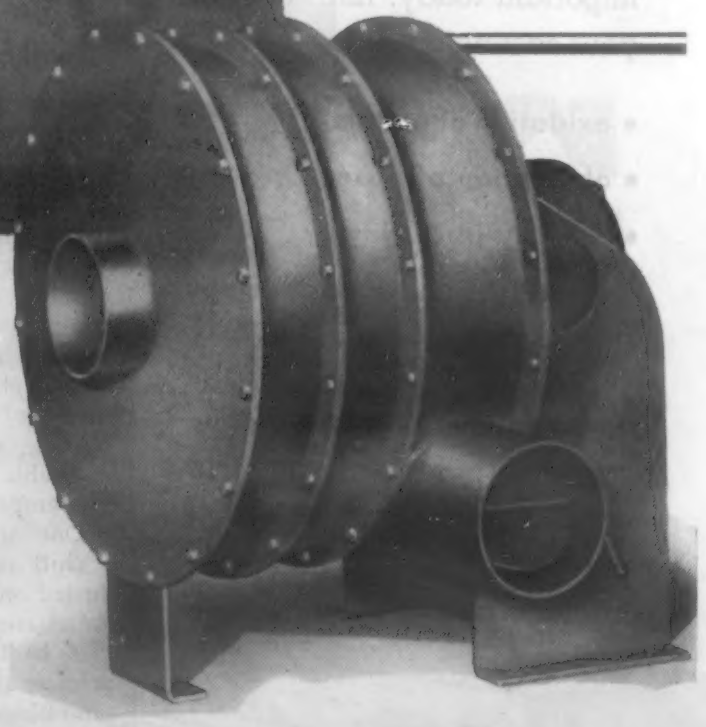

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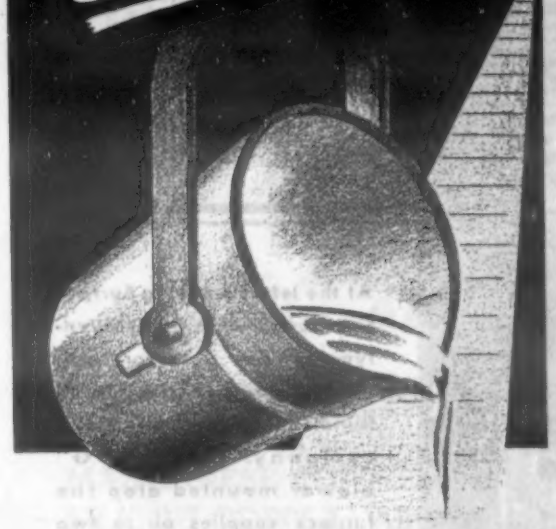

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from which the metal is drawn is continually open to the atmosphere. The flow of metal is controlled by shutting the blast on and off.

The name "syphon brick" is anomalous in so far as it implies the syphoning of a liquid from one level to another. The working of syphon brick is dependent on the difference in atmospheric pressure between the interior and exterior of the furnace.

The metal is exposed to the atmosphere through a channel that is similar to the spout of a teapot ladle. Under static conditions—that is to say, without the blast on—the atmospheric pressure inside the cupola well and at the cupola spout are the same; therefore, the metal will not flow down the spout.

If the blast is put on, the pressure inside the well will be greater than that at the spout, and the level of the metal in the well will be depressed, causing it to rise in the channel and flow over. Further, when the blast is on, metal will be melting in the melting zone replacing the overflow.

Since the difference in the level of molten metal inside the cupola well and at the cupola spout will be constant with the blast pressure, the amount of metal melted will be equal to the amount of metal drawn off. Thus, a constant quantity of fluid metal is retained in the well.

This is an advantage in that it removes any danger of metal rising to the tuyeres or, conversely, of there being too little metal to ensure a thorough mixture. The ease with which the metal flow can be controlled allows the use of quite small ladles at the cupola, and there is no need for a re-distribution from a large ladle, such as is often necessary when tapping out.

Metal handling, installation details, technique of operation, slagging procedure, preparation of brick, etc. are discussed.

E. R. Dunning, *Foundry Trade J.*, Vol. 71, Dec. 30, 1943, pp. 341-345.

Malleable Iron Castings Problems

Condensed from "The Iron Age"

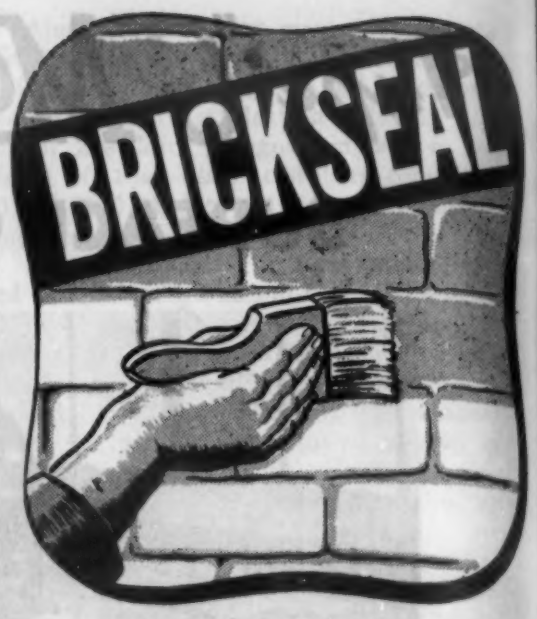
A discussion of feeding of castings, chill preservation, and the use of synthetic sands was a part of the London annual conference of the Institute of British Foundrymen.

Spherical shaped feed-heads were recommended, and a case was cited where joint feeders could be used to good advantage; the case in point involved a heavy section at a higher level than the feeder. However, it was suggested that atmospheric feeding would not be very applicable in malleable foundries, due to the long freezing range of malleable iron.

One speaker preferred, for some jobs, a chill coating of shellac with fine sand dusted on it, rather than the more conventional core-all coating. It was emphasized that badly scaled chills are a source of primary graphite formation, and should be sand-blasted or replaced.

The high permeabilities possible by the use of synthetic sands, even in the densely rammed condition, was illustrated by data. Thus, sand strength may be raised without resorting to excessive venting.

—*Iron Age*, Vol. 153, Jan. 20, 1944, pp. 68-69.



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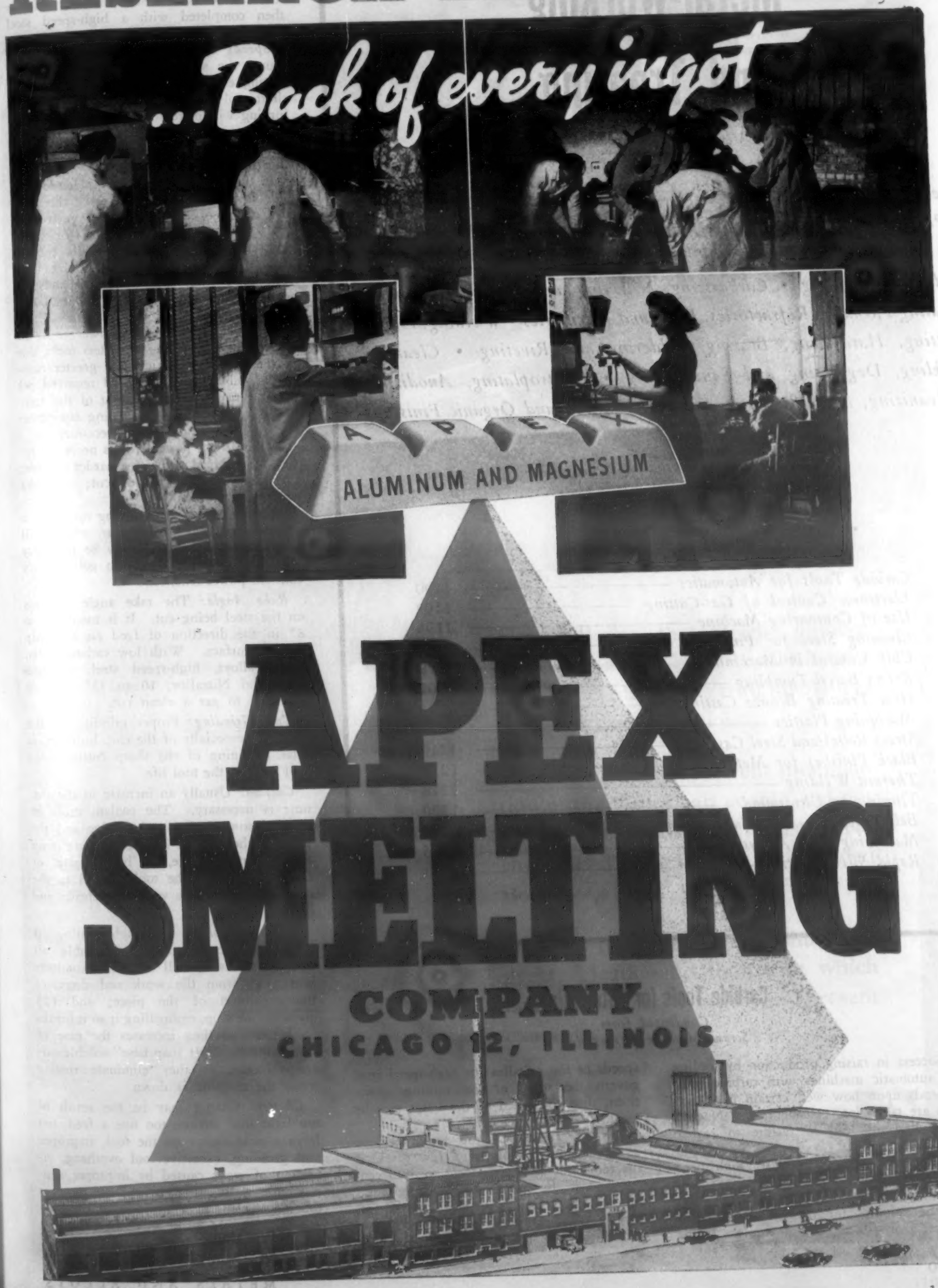

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Carbide Tools for Automatics

Condensed from "Screw Machine Engineering"

Success in raising production by tooling up automatic machines with carbide tools depends upon how well certain basic factors are taken into consideration. Neglect of these will lead to failure to realize maximum output.

Governing Conditions: If high-speed steel is used for some operations (drilling, tapping and threading), the speeds of the spindles for these tools must be slower than for the carbide tools. If the speeds of the spindles for high-speed steel govern the speed of the turning operations, then the speed of the latter may be too low for carbide tools.

Cut-Off Tools: Carbide tools may be used for cut-off tools in a few cases, if the tool does not have to cut to dead center, and if the speeds are very high, but in most cases carbide tools are unsatisfactory if the cut must be made to dead center, due to the formation of a built up edge, rapid dulling and flaking of the tip.

However, in some cases, a carbide cut-off tool can be used to start the cut, which is then completed with a high-speed steel tool.

Speeds and Feeds: Too low a speed causes the steel particles to weld to the cutting edge, giving a rough finish and a short tool life. Too fine a feed on rough turning will increase the wear of the tool; likewise, the fine chips increase the chip disposal problem as they tend to ride the chip breaker.

In the case of a form tool, a harder carbide is preferably used to resist the abrasive action of the fine feeds. A feed of 0.010 to 0.020 in. is common for single point tools or tools of the roller turning type. The speed for single point tools turning, boring, and facing depends on many factors, but is usually about 200 to 350 s.f.p.m.

Horsepower: The horsepower must be greater than for high-speed steel tools, due to the higher speed and the greater number of cubic inches of metal removed per min. Usually, reconditioning of the spindle is ample to adjust existing equipment for the higher horsepower necessary.

If this is not possible, it is necessary to: (1) reduce feed and use a harder carbide; (2) reduce the depth of cut; and (3) reduce the speed.

Roughing Cuts: In roughing cuts sudden speed accelerations may occur, which will chip a carbide tool. It may be necessary to split the roughing cut to get a fairly constant power balance.

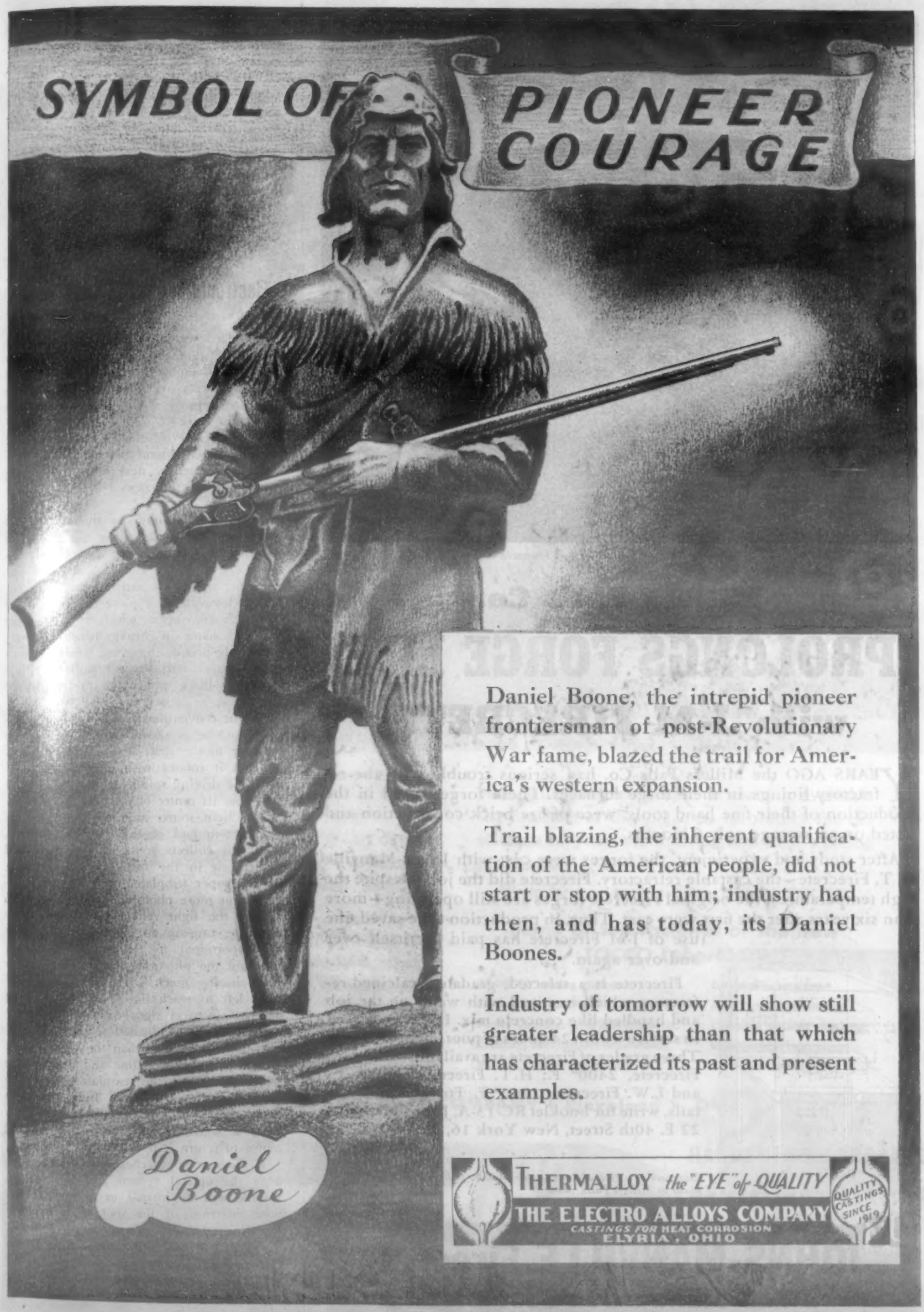
Rake Angle: The rake angle depends on the steel being cut. It is usually 4 to 8° in the direction of feed on the chip breaker surface. With low carbon steels, nickel alloys, high-speed steel, stainless steel, and Nitralloy, 10 to 15° may be necessary to get a clean cut.

Tool Grinding: Proper grinding of the tool, and especially of the chip breakers, is vital. Honing of the sharp cutting edge will increase the tool life.

Coolant: Usually an increase in the volume is necessary. The coolant must be directed toward the cutting edge and the point of the tool; it is best to direct it up to the cutting edge, or horizontally, or from the back of the tool parallel to the top. Spasmodic flow will cause checks and cracks.

Type of Coolant: A straight cutting oil is unsatisfactory. A good soluble oil solution works as well as it (1) conducts heat away from the work and decreases the expansion of the piece; and (2) quenches the chip, embrittling it so it breaks up better and thus increases the ease of chip control. "Soft soap base" soluble oils are valuable, as they eliminate rusting when the machine is down.

Chatter: Chatter may be the result of too light tool section, too fine a feed, too large a nose radius on the tool, improper tool grinding, excessive tool overhang, vibration of work caused by improper support, too dull a tool, a cut spread over too long a length of the cutting edge, or spindle play. Many of these are overcome in new equipment. Carbide tipped centers



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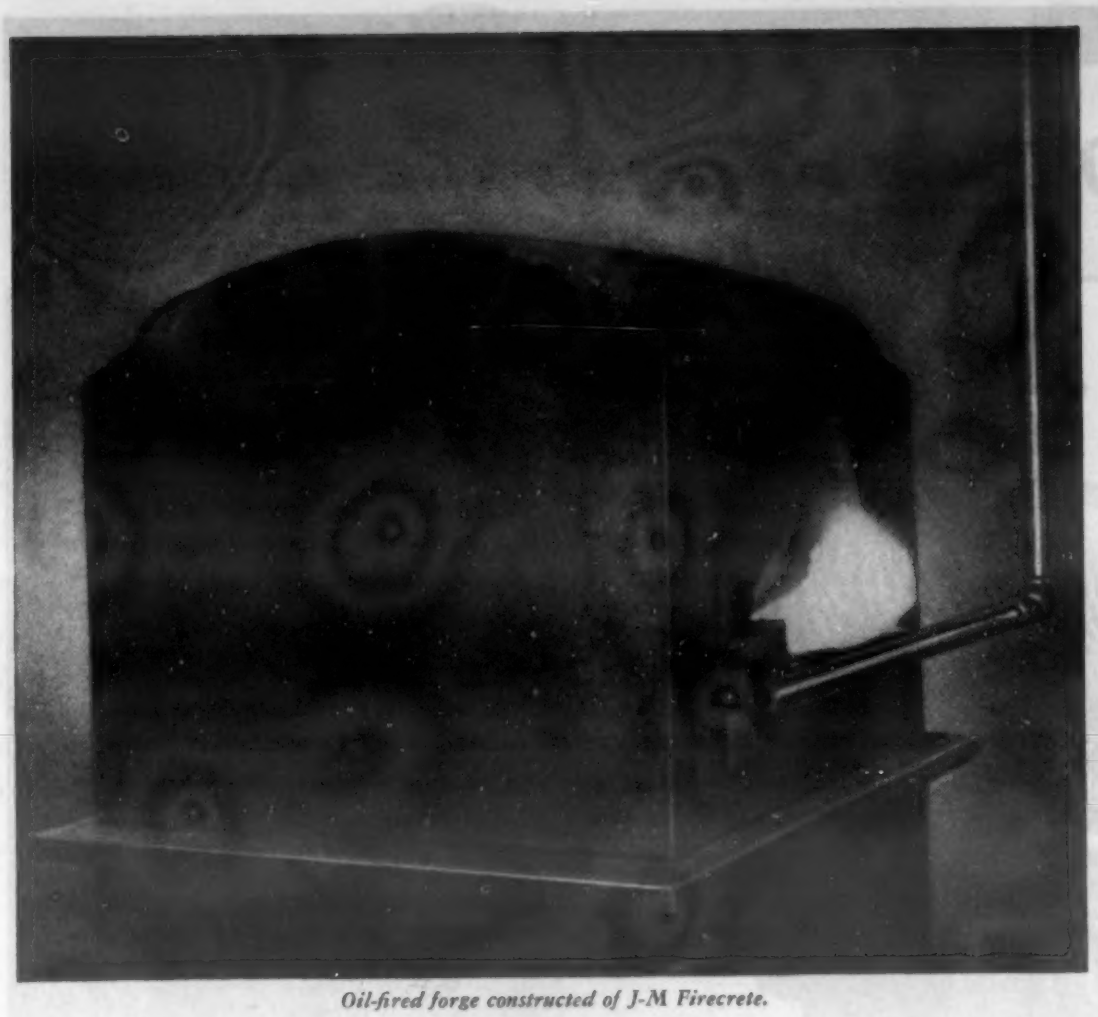


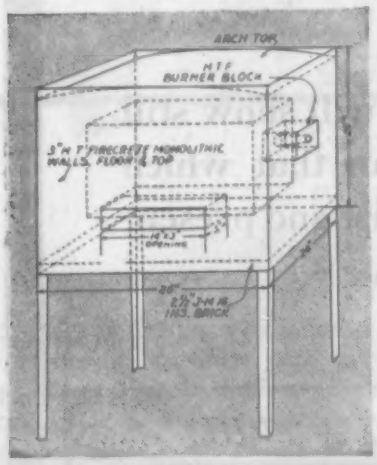
Oil-fired forge constructed of J-M Firecrete.

Millers Falls Co.

PROLONGS FORGE LIFE with J-M FIRECRETE

YEARS AGO the Millers Falls Co. had serious trouble with the refractory linings in their forge furnaces. These forges, used in the production of their fine hand tools, were of fire brick construction and lasted on an average only 6 months.

After study and experiment, the forges were cast with Johns-Manville H. T. Firecrete—the castable refractory. Firecrete did the job. Despite the high temperatures, the original Firecrete forges are still operating—more than six years after the first were cast. Thus, in production time saved, the use of J-M Firecrete has paid for itself over and over again.



Firecrete is a selected, gradated, calcined refractory which is mixed with water on the job and handled like concrete mix. It can be placed in service within 24 hours of pouring or tamping. Three grades of Firecrete are available—Standard Firecrete, 2400° F.; H.T. Firecrete, 2800° F.; and L.W. Firecrete, 2200° F. For complete details, write for booklet RC-13-A, Johns-Manville, 22 E. 40th Street, New York 16, N. Y.

* * *

Diagram of a typical forge at the Millers Falls Co. in their plant at Millers Falls, Mass.

JM JOHNS-MANVILLE Firecrete
The Standard in Castables

may also help to reduce chatter.

If these conditions are observed, automatics may be successfully tooled with carbide tools. Good results have been obtained with magazine type automatics for turning drills, reamers and taps, and with Swiss type machines.

—C. W. Blade. *Screw Machine Engrg.*, Vol. 5, Feb. 1944, pp. 34-39.

Electronic Control of Gas-Cutting

Condensed from "The Welding Journal"

An electronic control designed to automatically guide a machine completely around a template, which consists of a pencil drawing on white paper, will do much to improve quality and reduce scrap and extra work.

The operator is relieved of guiding the driving wheel around the template, meanwhile planning the next job, or adjusting torches or cutting speed in the current cut.

This control eliminates the human element and makes as many pieces as are required. The inspector can simply inspect one piece of each lot, assured that all other pieces are satisfactory.

The template is a piece of white paper or cardboard, upon which is drawn the desired shape in heavy pencil or ink, preferably pencil. Spraying templates with clear lacquer will prevent soiling. Blueprints or black and white prints may be used.

To the conventional manual-operated cutting machine is added another gear to the steering motor shaft and a drum, geared so that it rotates with a ratio of 1-to-1 with the driving spindle. The drum has a lens near its center of rotation.

The light source and lens flood the entire bottom end of the drum with light. The lens collects some of this light and projects it in the form of a small spot on the paper template.

One or more phototubes are mounted to receive the light reflected back from the template, causing an electrical signal that is proportional to the amount of light reaching the phototubes. Since the black line absorbs much light, the amount of light left to reach the phototube is small and its electrical signal will be small.

The control is adjusted so that the steering motor is at rest when the spot of light is half on the black line and half on the white surface of the template adjacent to the line. If the spot of light moves in either direction away from its correct position, a signal is given to the steering motor to return it to its proper position.

If the spot approaches closer to the line, both the optical system and the driving spindle will be rotated in a counterclockwise direction; if the spot tends to leave the line, the two move in a clockwise direction. When following a curved line, the spot will not be quite centered on the line, but more of its area will be on white paper than on the black line. A smooth, clean cut results.

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Here, at your service, is a 19,000 sq. ft. laboratory . . . completely equipped and expertly staffed . . . to help you blast war-production bottlenecks TODAY . . . and to guide you to valuable discoveries for TOMORROW.

Competent TOCCO Engineers, located near you, will gladly cooperate in making available the facilities of this big, new laboratory for the solution of your new heating and heat-treating problems.

Write for free booklet, "Results with TOCCO"

Some of the facilities of the new TOCCO Laboratory

24 TOCCO heating stations.
Frequencies 1000 to 450,000 cycles.
Power Capacity: Total 2100 kilowatts.
Creative, development department.
Design, drafting department.
Chemical Laboratory.
Metallurgical Laboratory.
Complete machine shop.
Experimental Laboratory.
Total floor space 19,392 sq. ft.

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Calm, calculating, confident—the trained fighter pilot gets in his best "licks" after he has been under fire. Much of his confidence is inspired by the known durability of his plane, for its aluminum alloy parts have been heat-treated for the vigorous demands of tough fighting.

R-S pioneered in the development of Salt Bath Furnaces for the solution heat-treatment of aluminum alloys. They produce uniform physical properties and high capacity in minimum floor space. The R-S Convection Type Furnace is recommended for conditions where the Salt Bath is not applicable.

If you need additional facilities for heat-treating aluminum aircraft parts or stampings, we shall be glad to submit detailed information on the equipment required.

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R-S PRODUCTS CORPORATION

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R-S Furnaces of Distinction

ANNEALING CONVECTION ROTARY HEARTH SALT BATH FORGING
CONTINUOUS CONVEYOR PLATE AND ANGLE HEATING METAL MELTING CAR HEARTH

★ ★ BUY WAR BONDS ★ ★

In the case of cutting a square corner, slight errors are bound to result, but it will not exceed 1/64 in. at most. In actual operation these errors are well within the permissible tolerances for all work encountered yet.

Due to the fact that the machine constantly compares the torch position directly with the template, cumulative errors resulting from the driving wheel slipping are not present. The electrical controls operate around a square corner more rapidly and accurately than could be done manually.

The speed of rotation of the driving spindle, when allowed to rotate freely, is about 100 r.p.m., or almost two complete revolutions per sec., insuring that when the driving wheel approaches a corner it is turned to its new position very rapidly.

It is expected that this type of control will soon become well known in many other manufacturing fields, in addition to the gas-cutting industry.

R. D. McComb. *Welding J.*, Vol. 23, Jan. 1944, pp. 11-15.

Use of Contouring Machine

Condensed from
"Western Machinery and Steel World"

The function of the contouring machine is to produce irregularly curved shaped members from straight sections or flat stock, which may be either constant or varied in cross section.

A contouring machine must be rugged to resist deflection. On the table is fastened a cast iron, Kirksite, Formite, or other block approximating the shape to be formed, and the metal is then ironed or stretched into this shape by a pressure cylinder.

Except with very ductile materials, the ironing method frequently fails to reach the elastic limit of the material, so that the spring-back is very variable and difficult to calculate.

Therefore, the contouring machine is preferably applied (1) with heavier material where the severity of the contour impels the material to flow beyond its elastic limit; and (2) with lighter material where the contours are not severe.

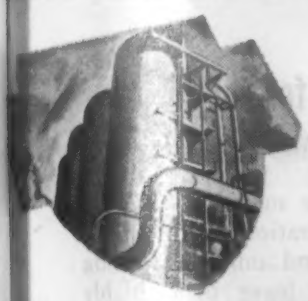
In the latter case, the material is stretched between a point on the table and the pressure cylinder, and then the shape rolled on the table into the stretched material. With the second method, very large shapes can be formed, the die cost is lower, and many shapes may be formed directly from the straight strips and sheets.

The principal advantage, of course, is that the material being stretched approximates its elastic limit before the forming takes place, and the element of spring-back is eliminated. Materials varying in tensile as much as 300% may be worked over the same form and give the same results.

A variety of simple shoe or roller pres-

GENERAL CHEMICAL

AGAIN GENERAL CHEMICAL CREATES NEW FACILITIES FOR SULFURIC ACID TO SERVE AMERICAN INDUSTRY

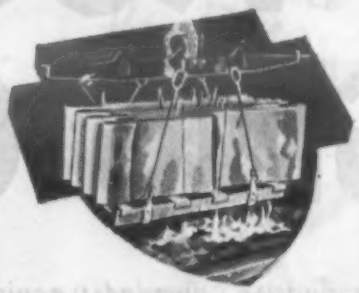


Petroleum

Alkylation, sulfonation, and improving color, odor, and stability of petroleum products.

Rayon

Used in the spinning bath in rayon manufacture.

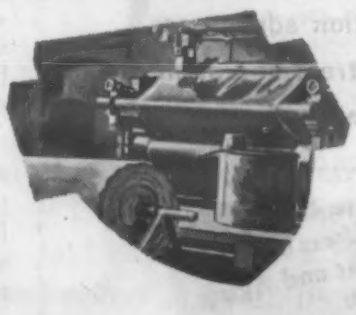


Steel

For pickling of steel sheets and castings; removes oxides and scales.

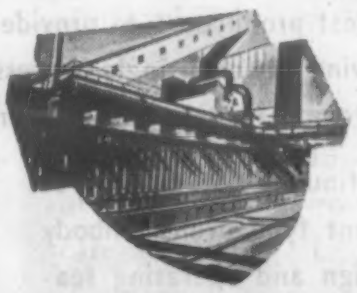
Paints

Raw material in production of pigments; for sulfonating drying oils.



Sulfonation

Sulfonating vegetable oils for water, fire, and mildew-proofing fabrics and textiles.

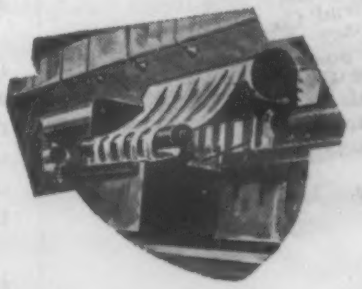


Coke By-Products

For washing toluene and benzene, raw materials for dyestuffs and explosives.

Fertilizers

Used in super phosphate and ammonium sulfate production.



Textiles

For carbonizing wools and for the dyeing bath in production of textiles.

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ROSS Continuous, Stationary or Compartment type ovens embody all the design and operating features that have recommended them to the world's largest producers of aluminum forgings.

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National Aluminum Cylinder Head Co.
Pratt & Whitney Aircraft Corporation.
Packard Motor Co.
Reynolds Metals Co.
Tube-Turns, Inc.
Wright Aeronautical Corp.,
and many others.

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sure application dies may be used. In certain cases an extra cylinder supplied for attachment at right angles to the machine provides means for stretching and ironing at one time.

The mounting of shapes on the table requires careful attention. In addition to proper mounting, rolls or shoes must be solidly bolted to the ram plate. Blocks to attain working height are preferably cast with the shape.

If the shape is to be made from light sheet, knurled grippers are not desirable as the knurling cuts in to the sheet. A better method is to hold with a corrugated die.

The general advantages of the contouring machine are: (1) relatively low cost compared with draw presses for similar work; (2) much lower cost for forms doing the work; and (3) considerable saving in time and wasted material as compared with operations where trimming must be done after draw press work.

At the present time, the contouring machine has a very useful field in aircraft, ship and truck body manufacture.

—*Western Machinery & Steel World*, Vol. 35, Feb. 1944, pp. 66-67.

Cleaning Steel for Finishing

Condensed from "Metal Finishing"

Addition of alkaline materials to rinse water in cleaning operations will usually give metals a clean and uniform looking surface, and yet will leave them highly unsafe to paint.

Among the alkaline materials that are sometimes added to rinse waters are caustic soda, soda ash, sodium chromate, sodium bicarbonate, etc. Such additions are ruinous to organic coating life.

Other materials that may remain on steel surfaces and that are not visually detectable, but that are very harmful to paint life, are other alkaline salts; alkaline earth salts, such as are always present in untreated waters; soluble salts of iron, such as the chloride or sulfate, remaining as residues from pickling operations, and soaps, wetting agents, or emulsifying agents.

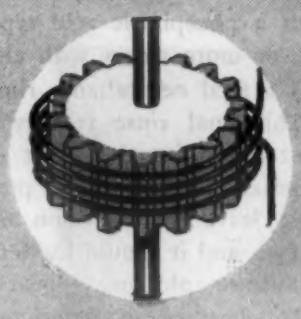
Contaminants that may be classified as immediately harmful are dust, heat scale, and various forms of grease and dirt. These materials usually produce immediate effects upon appearance or adhesion, and are so universally recognized as undesirable that their removal is usually stressed.

Latently harmful materials include those invisible contaminants listed above. The effects of these contaminants become readily apparent in accelerated tests, such as humidity or salt spray tests. They lead to early failure of the coating due to blistering or to corrosion of the steel under the paint film.

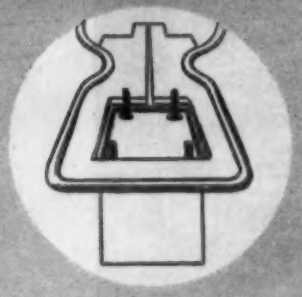
Several of the cleaning methods that are used in preparing steel for painting are mechanical methods, such as sand or shot blasting, or the use of abrasive papers; vapor degreasing; hydrochloric or sulfuric

HOW *Scientific Electronics* HEATING EQUIPMENT CAN

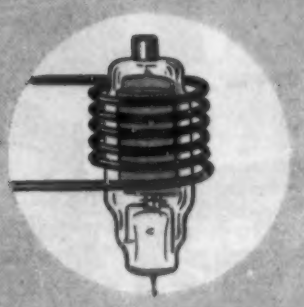
improve production . . . save time and money



Electronic heat can surface harden gear teeth or localized areas in seconds instead of hours . . . with precise control over depth and degree of hardness.

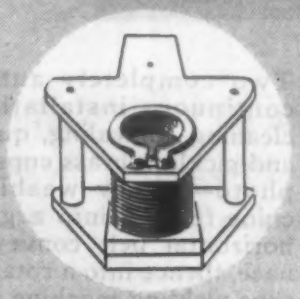


Electronic heat is revolutionizing brazing and soldering operations. Speed and efficiency are increased and wasteful after-cleaning operations are eliminated.

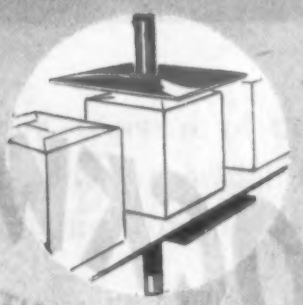


Electronic heat reaches through glass walls to degas metal elements in radio and fluorescent tubes without affecting the envelopes. Action is instantaneous.

Electronic heat can bond glass to metal faster with finer control of heated area. Often increases production units from hundreds to thousands per hour.



Electronic heat is ideal for soft metal melting pots. Lowers operating costs. Assures longer life of pot. Reduces gas inclusions of the smelt. Ends fire hazards.

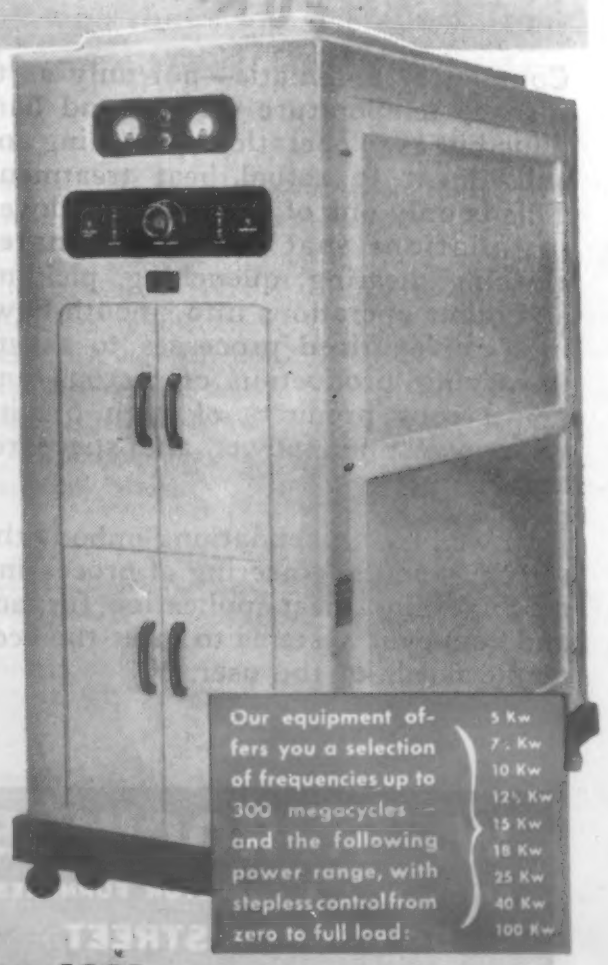


Electronic heat seals packages rapidly and completely in matters of seconds on continuous production lines. Packaged goods containing foods are sterilized.

This company has been designing and building Electronic heating units (induction and dielectric) *since 1921.* We have the advantage of *23 years* of pioneering knowledge and experience in this specialty.

Our equipment (known as "bombarders") has been used with satisfaction by the nation's leading electronic tube manufacturers for almost a quarter of a century, for exhausting and testing tubes.

Our apparatus has been time-tested for high efficiency and economy of operation, and is built to minimize maintenance problems. Our greater *variety* of models permits choosing the unit which is exactly suited to your application, and offers the *correct combination* of *power and frequency* which your jobs demand. You cannot get a power-wasting "misfit" machine from us. Before selecting any electronic heater, it will pay you to write us.



Our equipment offers you a selection of frequencies up to 300 megacycles — and the following power range, with stepless control from zero to full load:

5 Kw
7½ Kw
10 Kw
12½ Kw
15 Kw
18 Kw
25 Kw
40 Kw
100 Kw

Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY

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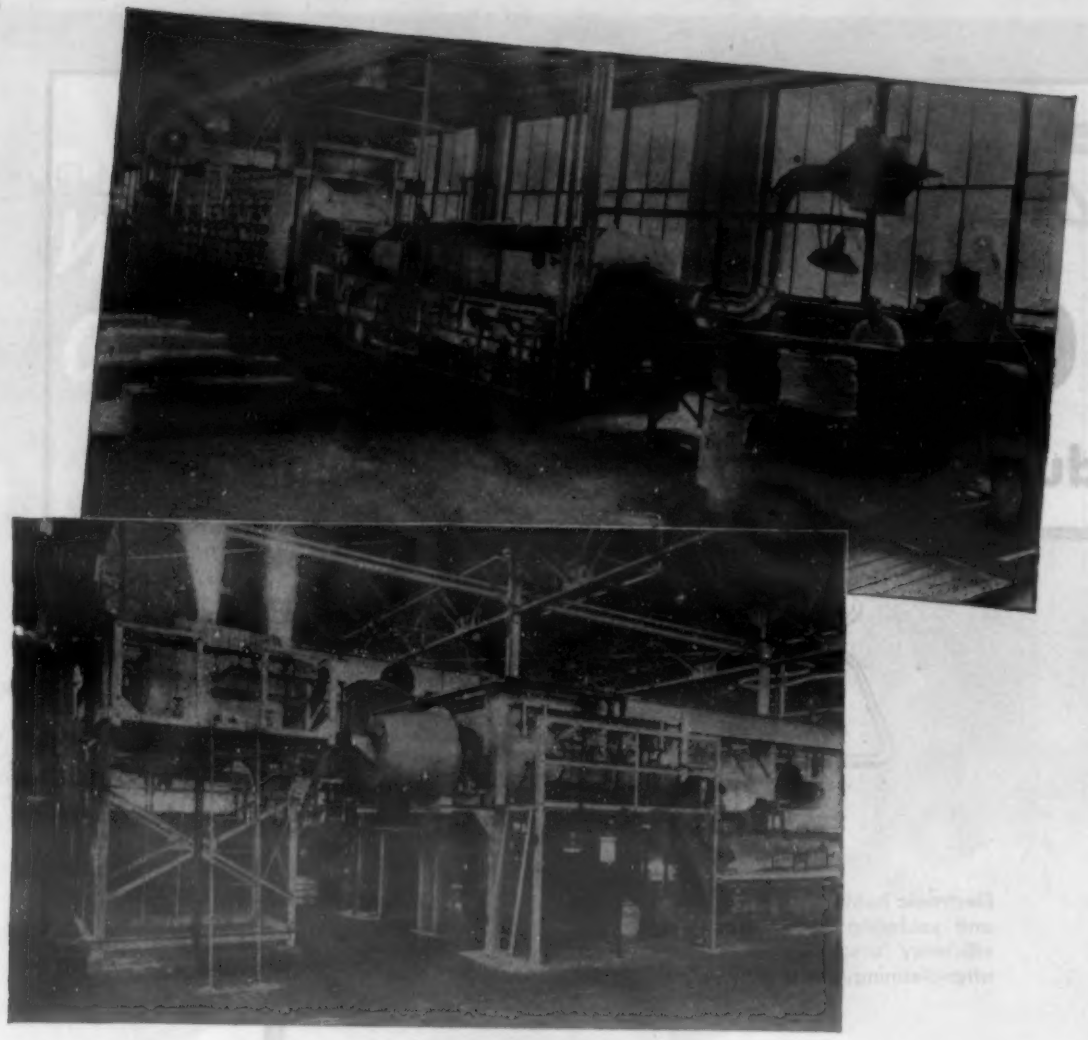

Two completely automatic, continuous installations for cleaning, annealing, quenching and pickling brass cups. Upper photo—rotary washing machine feeding into a gas-fired, horizontal belt conveyor furnace, thence into a rotary drum type pickling machine to a discharge table. Lower photo—rotary washing machine feeding into two gas-fired, revolving retort annealing furnaces, whence the work enters the rotary pickling machine.

ROCKWELL

COMPLETELY AUTOMATIC FURNACES

Completely automatic—not only as to furnace temperature control and handling but as to operations preceding and subsequent to actual heat treatment. This is only one of the many Rockwell installations that have coordinated cleaning, heating, quenching, pickling and other operations into smooth-flowing, conveyorized processes to assure unvarying production of ferrous and non-ferrous products of high quality with lowest manpower and space requirement.

Rockwell recommendations embody the selection and engineering of processing machines, fuel, heat application, furnace and conveyor systems to meet the economic needs of the user.

CONSULTING SERVICE

In addition to the furnace engineering service, Rockwell offers a complete metallurgical consulting service, involving investigations and recommendations concerning the proper heating and cooling of metal products for uniform results.

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BATCH TYPE & CONVEYOR FURNACES FOR EVERY HEATING APPLICATION

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acid pickling; alkaline cleaning, and cleaning in a phosphoric acid type cleaner.

None of the first four methods is suitable as a final cleaning operation. Phosphoric acid type cleaners are satisfactory. These cleaners contain, in general, phosphoric acid, grease solvents, wetting agents, emulsifying agents, and sometimes inhibitors of acid attack on steel.

This type of cleaner is least critical with respect to the final rinse solution. Traces of phosphoric acid not removed in rinsing are actually beneficial to paint life.

Cleaning Cycle

Following is a good cleaning cycle: (1) Removal of gross visible contamination with a phosphoric acid type cleaner; (2) one or more rinses with clean water; and (3) a final neutralizing rinse.

This final rinse is very important. It must neutralize the effect of any alkaline materials left after the previous rinse, it must leave no corrosion material on the surface, and it should leave the surface with a uniform, pleasing appearance.

To meet these requirements, the final rinse should contain 0.01 to 0.1% of either phosphoric or chromic acid, or both. It should have a pH between 3 and 5. It should contain an agent that will permit the rinse water to drain off in an even film, and it should be used hot, preferably boiling.

Work should be dried rapidly and completely after rinsing. The rinse solution should be carefully controlled with respect to phosphoric or chromic acid concentration and pH, and the concentrations of soluble salts, particularly chlorides and sulfates, must be kept below definite limits.

The hot, dilute phosphoric or chromic acid rinse largely neutralizes or removes the harmful contaminants discussed above. The phosphoric acid reacts with the steel to produce a thin film of insoluble phosphates, a desirable paint base.

Chromic acid leaves the steel "passive," *i.e.* coated with a very thin oxide film that tends to be self healing in the presence of adsorbed chromic acid.

Laboratory and service tests show that slightly better protection of steel by paint coatings is obtained if the steel is precleaned prior to the phosphoric acid type rinse with a phosphoric acid type cleaner rather than with an alkaline cleaner.

—Alfred Douty & Eugene Snyder. *Metal Finishing*, Vol. 41, Nov. 1943, pp. 754-757.

Chip Control in Machining

Condensed from "Mill and Factory"

Machining steel with carbides has brought to the fore the subject of chip control by chip breakers. A chip cut off a piece of work at 300 to 400 ft. a min. can be a potent hazard.

Chips that ribbon into long coils often interfere with machining, hence must be

Microstructure Shows the Resistance of INCONEL to Oxidation and Corrosion in Severe Annealing, Quenching and Pickling Operation

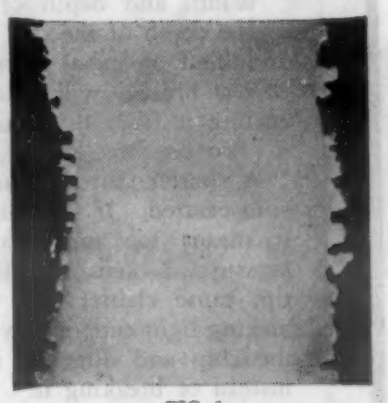

FIG. 1
5 x magnification

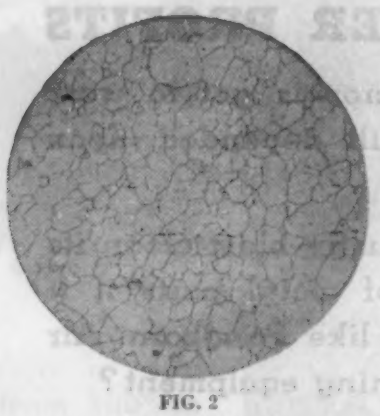

FIG. 2
200 x magnification

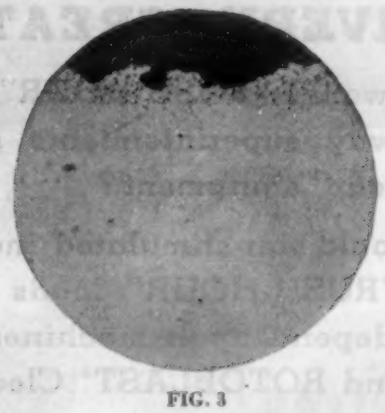

FIG. 3
200 x magnification

In order to relieve stresses between draws, brass shell cases are conveyed by basket through a continuous annealing-pickling process.

These photomicrographs were made from a specimen of ¼-inch Inconel wire taken from a basket which is still in use after more than 26 months.

In this treatment of shell cases, quenching with cold water spray immediately follows annealing at 1100° F.; oxide scale is then removed by immersion in an aerated pickling solution containing 10% sulfuric acid and 2.5% copper sulphate at 160° to 180° F.

Note, in the longitudinal section of Fig. 1, that the center of the wire is entirely sound after use under these severe conditions. Originally 0.25-inches in diameter, the section is now 0.2-inches, has a rough edge due to oxidation and corrosion, but shows a loss of only 20% in 26 months of service.

Detail of the interior structure of the wire is shown in Fig. 2. This structure, which is typical of normal Inconel, remains sound and free from any damage.

Fig. 3 shows a higher magnification of part of the oxidized and corroded surface of Fig. 1, supplements Fig. 2, and shows that the attack from service is slight and confined only to the surface of the metal.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*The details of this use of Inconel are published in the belief that they will be of interest and value to engineers and designers working on similar problems, although the use of Inconel today is subject to approved applications.

Close-up of welded Inconel annealing-pickling basket used for handling large shell cases.

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

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ON "RUSH-HOUR" SCHEDULE

MORE LOADS—FASTER
DELIVERY—GREATER PROFITS

HOW would "RUSH-HOUR" crowds get to work if subway superintendents still depended upon "horse-car" equipment?

How would war stimulated industry blast clean its daily "RUSH-HOUR" loads of metal parts if it didn't depend upon machines like Pangborn Air Blast and ROTOBLAST* Cleaning equipment?

CUTTING 50% OFF BLASTING TIME MEANS MORE TONS OF WORK CLEANED DAILY

when you get work to your cleaning room—75% of its total cost has been already spent in materials, labor and power. Why wait hours, days or weeks before you get your money back— due to "horse-car" cleaning methods?

Put your cleaning room on a "RUSH-HOUR" schedule by using modern Pangborn equipment to finish the job. Blast cleaning is your LAST OPERATION. Why delay it—when with PANGBORN you can get it out QUICKER—BETTER—and CHEAPER.

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ARMY E NAVY
For excellence in production

*Trade mark of Pangborn Corporation for airless blast cleaning.

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WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT
PANGBORN CORPORATION · HAGERSTOWN, MD.

removed frequently. Uncontrolled coils may make it hard to direct the fluid coolant tube, even if a flexible system.

According to the service engineer of Carboloy Co., Inc., the ground-in chip breaker has proved to be "the most satisfactory means of chip control yet evolved." It consists of a step that has been ground into the top surface of the tool so that the step curls up or breaks off the chip.

A deflected coolant tube can cause sudden heating of the carbide tip, followed by cooling, a condition that might crack the tip. Correct cooling helps prolong the life of the breaker, since most of the heat generated is carried off by the chips. The cooling of the hot chip increases the chip's brittleness, making it easier to break.

Width and depth of the breaker vary as the depth of the cut, feed, cutting speed and kind of metal being processed. The correct breaker will break off a chip after curling it from three-quarters of one turn to two or three turns.

A shorter chip indicates too much pressure exerted. If the chip coils too tightly, it means too much control. Excessive pressure shortens tool life, may crack the tip, cause chatter and waste power. In making light cuts, it may be possible to curl the chip and direct it into the chip pan instead of breaking it.

Breaker Width Variable

Sometimes it may prove beneficial to increase breaker width in relation to the increase in the chip cross section. It may be impossible to break tough chips with feeds of 0.003 to 0.007 in., where correct control may require increasing the feed rather than decreasing the width.

The size of the radius in the back of the chip breaker determines, to a large extent, the depth of the breaker. As the radius gets larger, it does not curl the chip enough to control and break it. A sharp radius tends to cause the chip to press too strongly against the shoulder, thereby chipping or breaking the carbide.

Appropriate radii are, in general, from 0.010 to 0.030 in., with the larger size applying to the larger breakers.

Control is sometimes done by changing the rake angles instead of by grinding chip breakers. One either decreases the rake angles to where the tool is practically flat topped, or by using negative angles, an advantage of the latter being the shorter grinding time needed, saving grinding costs and with less danger to the tip.

Negative back rakes add strength at the nose of the tool. Negative side rakes have been used with either negative back rakes or zero back rakes. The side rakes usually help to break chips through squeezing or compression.

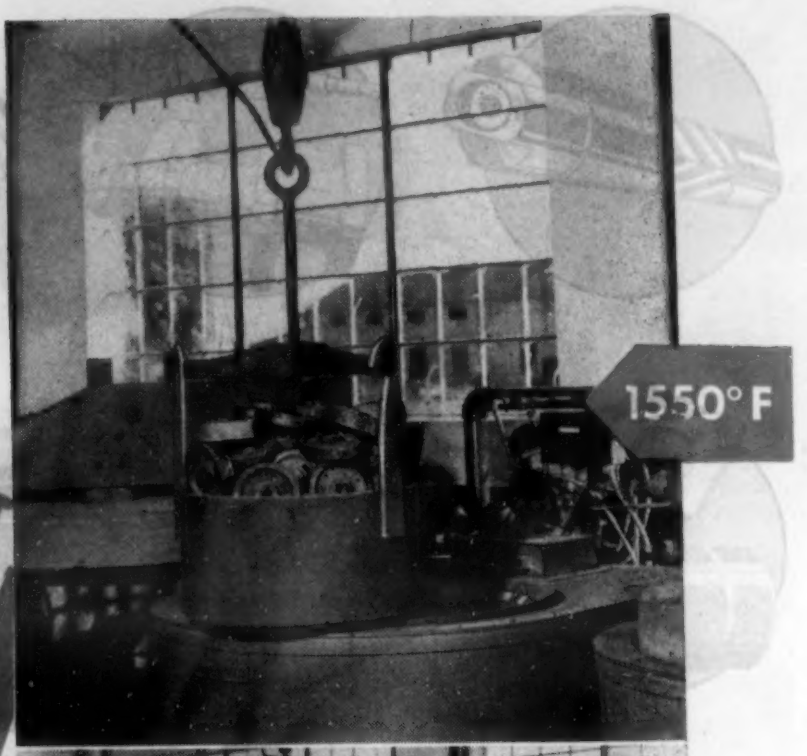
Excessive side rakes, however, may place such heavy loads on the tool as to unduly heat up. Side rakes may vary from 8° positive to 8° negative; a negative side rake of 3 to 8° is needed to control chips without the breaker. The harder the steel, the greater the side rake. Negative back rakes of from 5 to 10° are usually allowed.

Another means of control is to combine negative rake angles with a ground-in chip breaker.

—*Mill & Factory*, Vol. 34. Feb. 1944, pp. 110-111, 266.

Versatile!

The Lindberg Super-Cyclone Furnace



For all metal treating, utilizing heats from 300° to 1750° F., the Lindberg Super-Cyclone Furnace gives complete versatility.

For instance, in the photographs here, a charge of gear blanks is just going into the Super-Cyclone at 1550° F. Next a load of gate valve weldments is being charged for stress relieving at 1100° F., and below, 16 railroad frogs are lowered into a temperature of 700°F. for tempering. All using the same Super-Cyclone Furnace!

When a load must be reheated at a lower temperature, after quenching, the Super-Cyclone can be accurately brought down to the proper heat while the load is in the quench, saving precious time and rehandling.

The Super-Cyclone operates on a principle of fan driven hot air from an isolated heating chamber racing at high velocity through the most compact load to build up temperature with rapid uniformity. This allows temperatures to be built up or reduced with amazing speed. And there is a complete avoidance of radiant heat that causes distortion.

This revolutionary heating principle saves time and space, keeps work straighter and cuts production costs. Write for complete information to Lindberg Engineering Company, 2451 W. Hubbard St., Chicago 12.

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CYCLONE for accurate, low-cost tempering and nitriding
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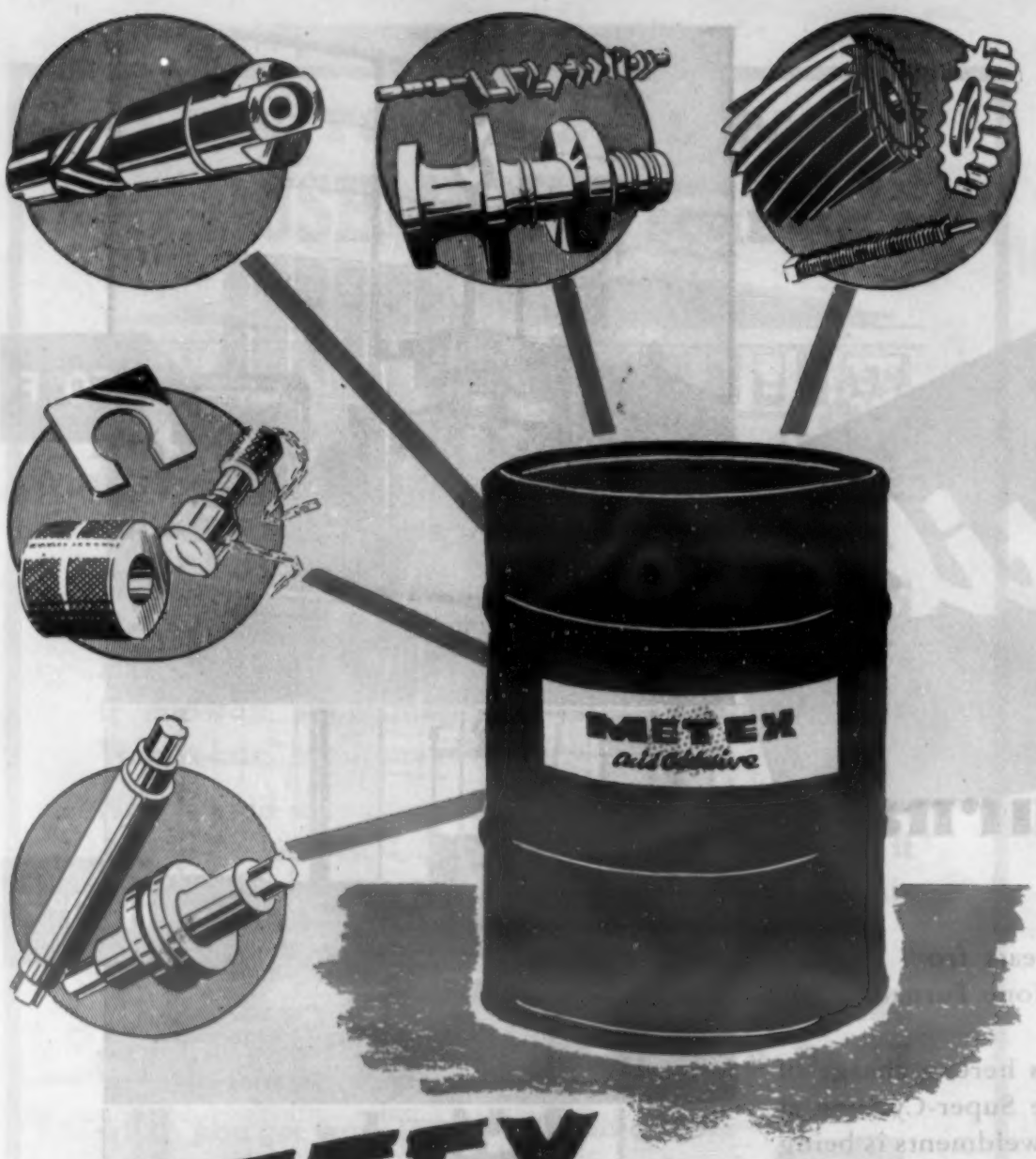

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- **Assures excellent results when used in Bullard-Dunn processing solutions.**
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Rotary Barrel Tumbling

Condensed from "Proceedings," American Electroplaters' Society

The "Roto-finish" method is a procedure for removing burrs from metal parts by tumbling them in a rotating barrel. The method is not to be confused with ball burnishing, in which burrs and rough spots are merely pieced down by the action of the balls. In the roto-finish process, an abrasive is used, resulting in burrs being ground off.

Two distinct methods are used—wet and dry. In the dry process, the parts are charged into a horizontal barrel, together with a fibrous abrasive-impregnated compound and "roto-burnishing chips," which are fractured limestone or granite.

No water is used with the mixture in this process. It is practically noiseless, and the parts come out clean and dry. When the barrel has run long enough for sufficient grinding to have taken place, the parts are separated from the abrasive materials by means of a vibrating separator.

This process is extensively used where parts are very delicate and require a mild polishing or buffing action. The average time required on steel parts ranges from 8 to 24 hr., and on aluminum and brass parts, 2 to 18 hr.

The wet process is more severe than the dry, usually requiring 1 to 6 hr. on steel parts and 15 min. to 2 hr. on brass and aluminum. There are three divisions of the wet process, namely, grinding, honing, and coloring.

In the grinding process, the parts are charged, together with limestone or granite chips, an abrasive paste, and water, into a water-tight barrel. The abrasive compound serves largely to maintain the abrasive quality of the chips.

No Damage to Surfaces

Small parts are handled en-masse. Frail and accurately machined parts can be deburred without distortion or damage to surfaces. Corners and outside edges and surfaces receive the most grinding action. Edges and corners can be ground to an appreciable radius, with neglible effect on surface dimensions.

A surface analyzer will usually show from 4 to 16 micro-inches surface improvement. Burrs on inside or recessed locations receive less action, but if there is an opening that will allow the flow of chips, considerable grinding will occur. External threads of close tolerance should usually be masked. Internal threads seldom need shielding.

Large parts of such weight and shape that they would nick each other are deburred singly. This pays if the part would require considerable hand burring.

For most purposes, the grinding operation is all that is required. If a brighter finish is necessary, grinding is followed by the honing operation. Honing is done with a mixture of burnishing chips and steel balls.

If the article is being prepared for plating, or for some other reason requires a still higher finish, "coloring" is carried out by ball tumbling, following the honing operation.

Several examples of the applications of

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ARMSTRONG'S INSULATING REFRACTORIES

Among the reasons for the widespread use of the Bullard-Dunn Process in plants which descale gears, dies, and precision threaded parts is the fact that it does not attack the base metal. Also, by its high "throwing power" it removes scale completely from tiny recesses and internal surfaces.

These unique advantages, coupled with its greater speed, make the Bullard-Dunn Process indispensable for production where time is at a premium and accurate work a necessity. Send samples of your work for an estimate. Write for booklet today.

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- Produces chemically clean surfaces
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these methods are described. Trigger guards are deburred, using wet-grinding only, 240 per machine load, in 1½ hr. One man operates three machines, thus deburring 720 pieces in 1½ hr. Hand deburring required 15 min. each, or 180 man-hours for 720 pieces.

A 55-lb. bronze casting, machined all over, required 6 man-hours to deburr by hand. It is Roto-deburred in 1½ hr., three parts to a machine, and one man operates seven machines.

This method of deburring is not a panacea for all deburring problems, but if parts do lend themselves to this method, it will do the work rapidly and economically.

—Fred P. Green. *Proc.*, Am Electroplaters' Soc., June 1943, pp. 17-20.

Heat Treating Bronze Castings

Condensed from "The Foundry"

Heat treatment to cure porosity in certain classes of bronze castings can be used only when the castings are structurally sound, made by satisfactory foundry methods, and only when the unsoundness is due to a certain condition of the metal.

Defects caused by faulty gating and risering cannot be remedied by heat treatment. The cracks, fissures, tears and strains produced must be overcome by good foundry technique. Good design is important in the production of sound castings.

Proper use of fillets at junctions of sections that meet at sharp angles and at the junction of sections of different cross sectional areas will tend to lessen tears and shrinks by having the fillets act as shock absorbers during the cooling cycle.

Absorbed combustion gases as well as those formed during the casting process will cause leakage in pressure castings, but good melting practice and sand control will eliminate it. Alloys more susceptible to oxidation should be deoxidized with agents, such as phosphor copper.

The use of choke gates and strainer cores is advocated as a means of eliminating dross and oxides. Elements such as aluminum, silicon, iron and antimony promote unsoundness in pressure castings, and should be avoided.

Metals are heat treated for several purposes: to relieve stress or strain caused by different working or cooling forces; to refine or rearrange the grain structure, and/or, to toughen or harden the alloy.

The first two reasons apply to leakage in pressure castings. Poor design or drastic changes in cross sectional area will cause stresses and strains due to uneven cooling rates. Annealing will remove these stresses and prevent leakage due to strains.

The authors have reason to believe that impurities affect the crystal structure. One pressure alloy tested gave a number of leaky castings, although no defects were apparent when the castings were cut up.

Annealing of the rejected castings resulted in satisfactory products, but the treatment had no effect on the mechanical properties of the alloy.

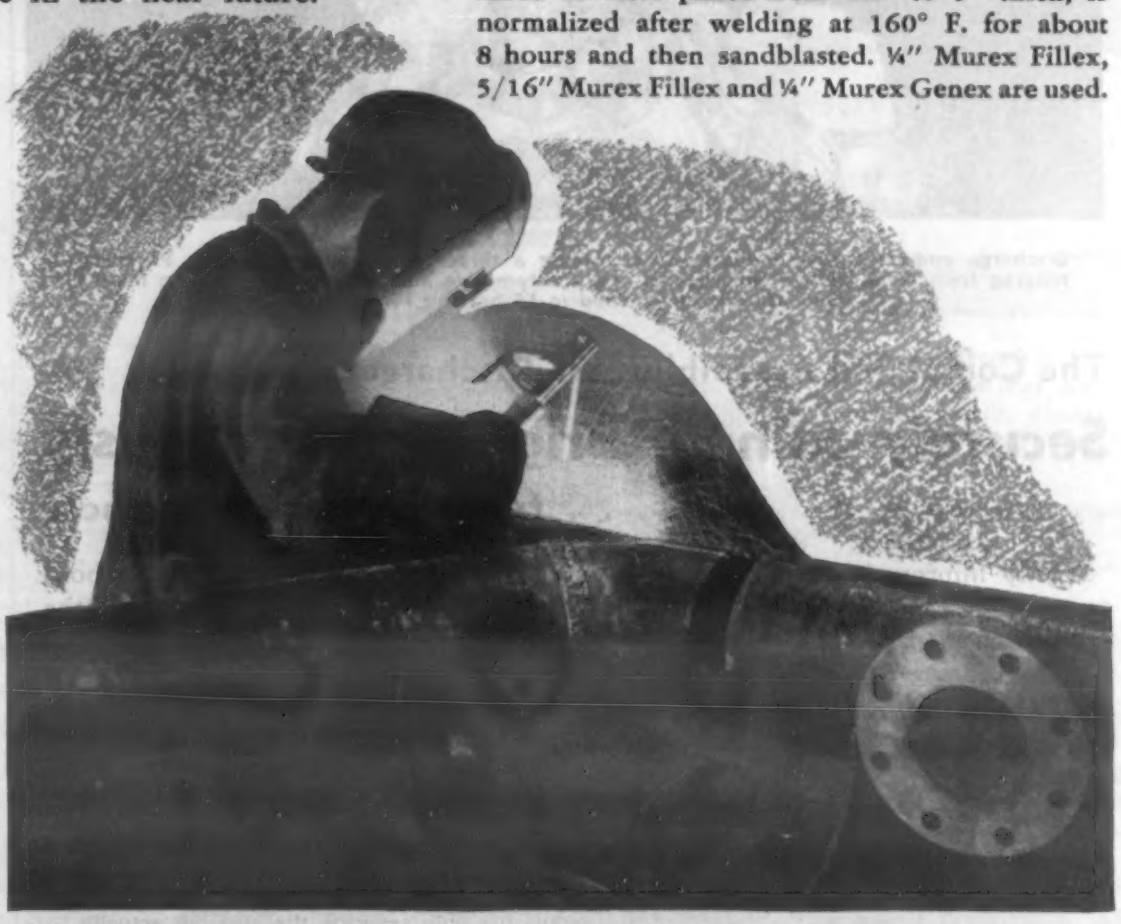
(Continued on page 1208)

THE QUANTITY PRODUCTION of electrodes to meet the requirements of war production has been, of course, our chief concern. Research and development work has not been neglected, however, and a continuous program devoted to the improvement of present electrodes and the creation of new ones is carried on continuously at our modern research laboratory in Woodbridge, N. J.

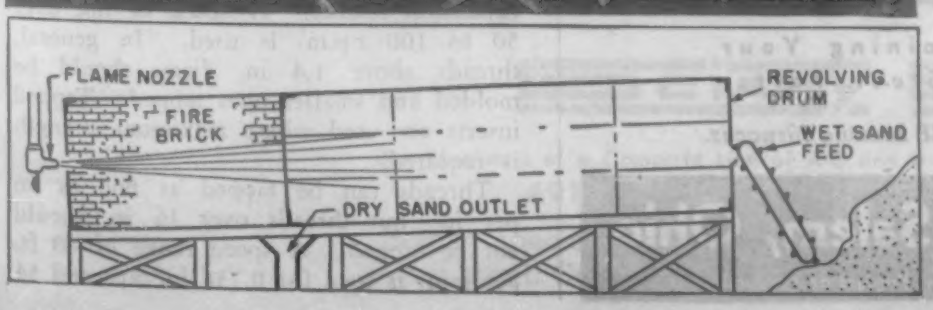
As a result of this important work, announcements of several new Murex electrodes will be made in the near future.

OILGEAR SPECIAL 200-300-TON GOOSENECK PRESS for straightening large, long tubes. Welded frame is made of steel plates from 1½" to 5" thick, is normalized after welding at 160° F. for about 8 hours and then sandblasted. ¼" Murex Fillex, 5/16" Murex Fillex and ¼" Murex Genex are used.

ERECTION OF A 30,000-TON UNIT SYNTHETIC RUBBER PLANT, one of six built by the Blaw-Knox Company, required approximately 11 miles of piping ranging in size from 2" to 30" which called for over 25,000 welds. These piping systems required designs for a wide variety of conditions, such as high pressures and temperatures, refrigeration, vacuum, hazardous liquids, gases and corrosive chemicals. Murex electrodes were used.



(Below) WELDS IN SAND DRYER WITHSTAND HEAT EXTREMES AND ABRASION. 450 tons of sand pass through this revolving dryer cylinder during eight hours' operation at red heat temperature which sometimes drops below zero after shutdown. Welded with Murex Molex electrodes, the welds outlast the dryer's half-inch steel liner plates. The liner plates are made in three segments, with a girth weld and 3 horizontal welds for each section.



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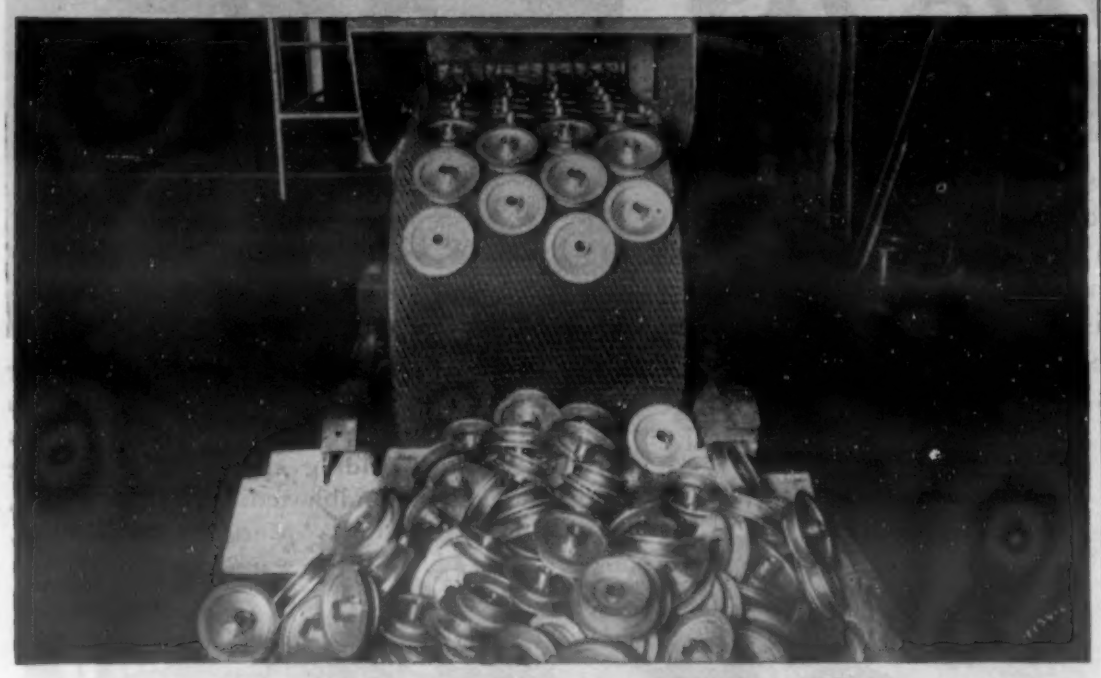


Discharge end of a continuous furnace brazing a three piece pulley assembly. Products ranging from small radio tube parts to heavy automotive and refrigerator units are neatly and economically joined in EF brazing furnaces.

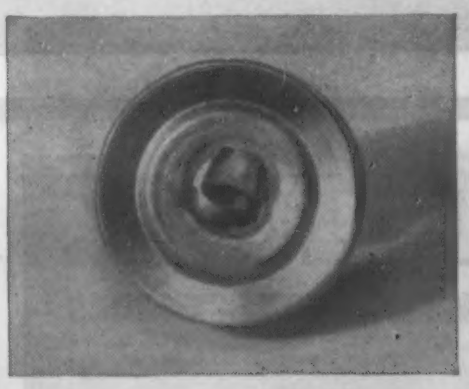
The Completed Assemblies are Discharged

Securely Joined, Bright, Continuously

. . . from EF Brazing Furnaces

"Greatly improved results—neater, stronger joints—60 to 75% faster, at about one-quarter the former labor cost," that briefly is the report received from the production manager of a prominent midwestern plant after installing an EF continuous brazing furnace for joining some of their assemblies.

Within a month after installing their first brazing furnace, a second similar but larger furnace was ordered for joining other products—both furnaces are now operating side by side, joining all kinds of assemblies—large and small—neatly, economically and securely.



Result of a laboratory test on an automobile fan pulley in which the hub was brazed to the web. The complete pulley was placed in a press and pressure applied. The steel web broke but the brazed joint held securely.

Products difficult or expensive to make in one piece can be made in several pieces and joined —thus not only reducing the cost but actually improving the quality and appearance. Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in the production line in your shop.

Strong, leak-proof joints are made and the completed unit is discharged from the furnace —clean and bright.

Any number of joints in the same product or any number of pieces can be joined at one time. The most intricate parts or assemblies are made to actually "grow together," and joints made which are as strong, or even stronger than the original parts. On some parts it is possible to anneal and braze in one operation.

Investigate the brazing process for your products. With slight changes in design you may be able to join your metal assemblies, neater, cheaper and stronger by this method.

Investigate This Process for Joining Your Aluminum, Brass, Copper or Steel Parts.

Send for printed matter showing various types of EF brazing furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Annealing for two hours at 1200 F. of 25 leaky castings resulted in the acceptance of 21 of these after the first treatment and two of the others after another anneal.

In practice it has been found that the percentage of rejects has fallen from as high as 50% before annealing to 3 or 4% after. It must be emphasized, however, that only castings with sound structures can be saved.

—J. W. Horner & F. A. Mason. *Foundry*, Vol. 72, Mar. 1944, pp. 109, 187-189.

Machining Plastics

Condensed from "The Iron Age"

Cutting speeds for machining plastics are generally higher than for metals. Different results are obtained with the various grades of plastics. In turning resins, a bronze tool bit is used for small production and will not require dressing for the first 100 to 150 cuts. For large production, high-speed steel tools are preferred.

Tools are sharpened very much as for brass work. Clearance should be 10° to 20°, and slightly negative or zero rake is desirable. The tool should be set at right angles to or 1° to 2° above the center of the material, and cutting edges should be in condition to produce long ribbon shavings.

Spindle speeds range from 450 to 6000 r.p.m., and should be regulated to a speed of 600 ft. per min. In machining laminated plastics and vulcanized fibers, cemented carbide tool tips are used for turning and boring. The tool should be sharp and have a clearance of at least 30°.

Laminated plastic and vulcanized fiber tubes, rods and washers can be machined in automatics and hand screw machines. Recommended cutting feeds on automatics are: Drilling, 0.007 to 0.015 in. per rev.; turning, 0.010 to 0.015; cutting off, 0.002 to 0.005; forming, 0.002 to 0.003.

For hand screw machines, spindle speeds are 800 to 1000 r.p.m. for 1-in. diam. and over; under 1 in., 1500 to 2000 r.p.m. For automatic machines, 2500 r.p.m. for over ⅝ in. diam., 3600 r.p.m. for 7/16 to ⅝ in., and 5000 r.p.m. for ⅛ in. and less are advised.

Good results are obtained in drilling holes up to 3/16 in. by using high-speed drills with slightly negative rake ground on the cutting lip. Speeds range from 2800 to 12,000 r.p.m. for small holes.

When drilling methyl methacrylates, use a drill with a flute angle of 17°, with lip angle of about 70° and lip clearance of 4° to 8°. The best lubricant is a mild, warm soap solution.

Reaming plastics is not recommended; it is best accomplished by the use of an expansion reamer. A speed of not over 50 to 100 r.p.m. is used. In general, threads above 1.4 in. diam. should be molded and smaller ones tapped. Tapped inserts are used where maximum strength is required.

Threads can be tapped as fine as 56 per in., but threads over ¼ in. should not be tapped. A speed range of 40 ft. per min. is used for 0.736 in. taps and 54

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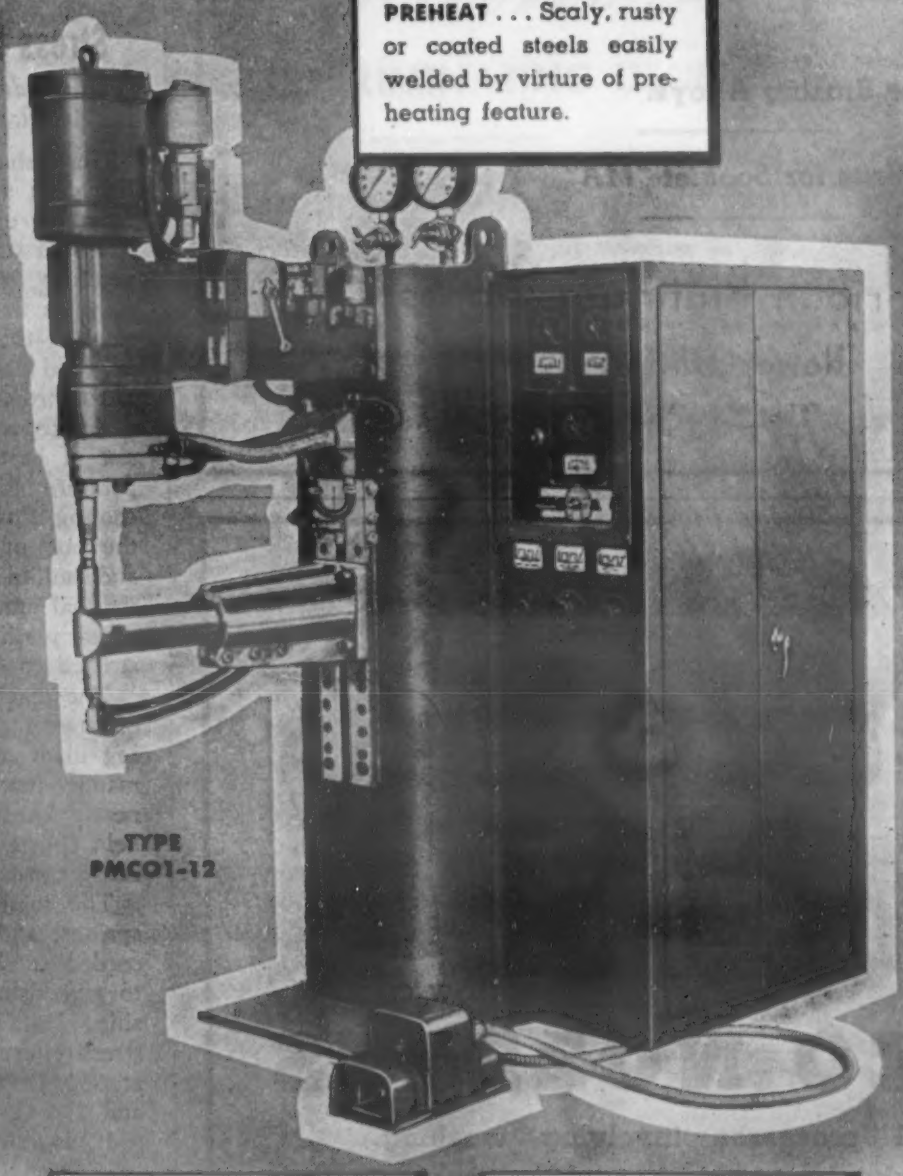

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Also many other standard and special compositions.

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ft. per min. for 0.0590 in. taps. For tapping laminated plastics and vulcanized fibers, high-speed taps 0.002 to 0.005 in. oversize are recommended.

External threads may be molded in split halves. These may be produced by self-opening dies with high-speed steel chasers. Milling may be accomplished by any standard machines using standard cutters, especially the carbide tipped variety. The cutting speed is about 400 ft. per min.

Sawing is done at 1200 to 1300 ft. per min., using a band saw with 14 to 18 teeth per in. On a jig saw, the blade is a No. 3 jewelers', with 22 teeth to the in. Finishing operations are grease burnishing, dry tumbling and wax finishing.

—W. S. Low, Jr. *Iron Age*, Vol. 153, Feb. 10, 1944, pp. 59-61, 137.

Stress Relief and Steel Castings

Condensed from "Transactions," American Foundrymen's Association

Tests show that stresses can be re-established in a casting by cooling too rapidly from the elevated temperature at which it has been stress relieved. The limiting temperature to prevent re-establishment of stress is fixed by the yield strength of the steel at this temperature as related to the imposed stress due to differences in cooling rates throughout the casting.

A proper stress relief cycle should consist of heating to a sufficiently high temperature to relieve the stresses rapidly, cooling slowly to a temperature at which the rate of plastic flow is relatively low, and holding at this temperature until the thermal gradient and desired amount of the stress gradient are removed before unrestricted cooling is allowed to occur.

The machine used for determining rates of stress relief applies continuously decreasing loads to a tensile specimen in such a manner that the specimen remains at a very nearly constant strain. The specimen is held constantly at whatever temperature is being considered.

The load is applied through iso-elastic springs, and the indicated deflection is recorded at short, regularly timed, intervals to give data for a time vs. stress relationship. Data are given for cast carbon steels, stress-relieved from different initial stresses at 550 C. (1020 F.), 650 C (1200 F.), and 750 C. (1380 F.).

It is shown that the precentage of stress relief is equal to $\left(-b \log \frac{t}{t_e}\right)$, in which b is a constant depending upon the temperature and material, t is the elapsed time after stress relief was started, and t_e is the time necessary to completely relieve the initial stress.

It is probably safe to assume that the relaxation of steel is a simple exponential function of temperature, which is expressed as $\log t_e = R_1 - R_2 \theta$, in which R_1 and R_2 are positive constants, valid over the range of temperature used in their experiments, and θ is the temperature.

—E. A. Rominski & H. F. Taylor. *Trans.* Am. Foundrymen's Assn., Vol. 51, Mar. 1944, pp. 709-727.

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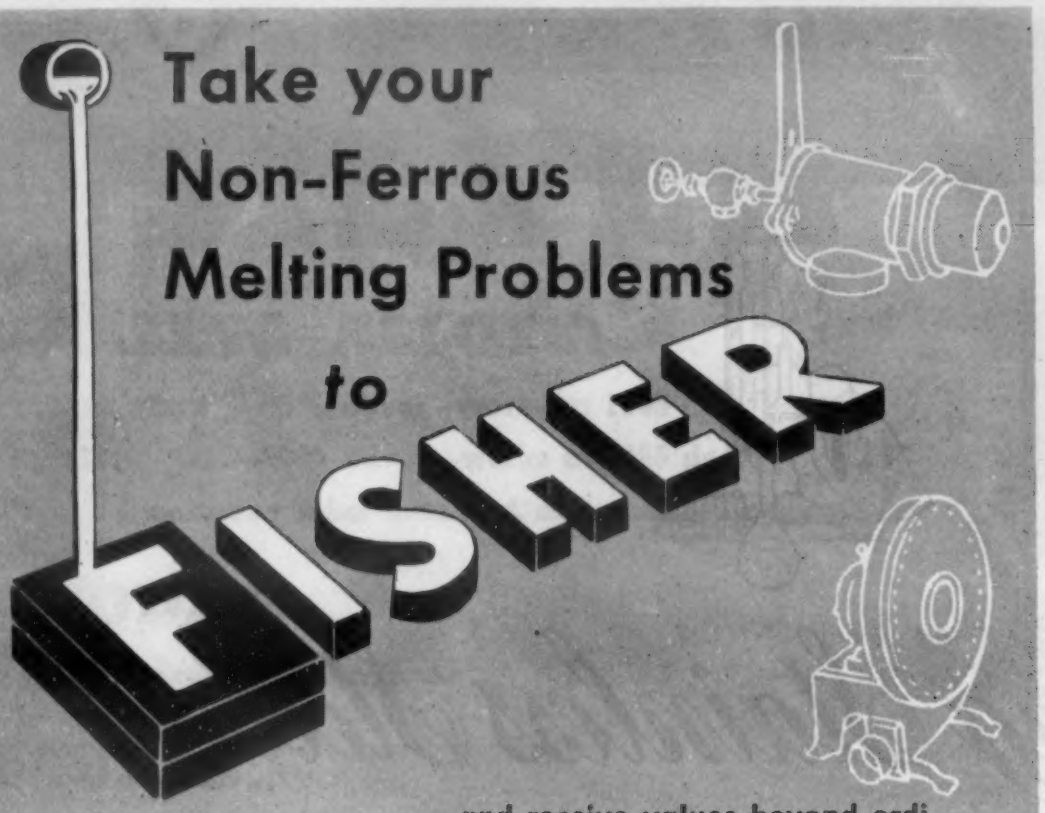

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Fisher FURNACE COMPANY

Engineers and Manufacturers

Black Finishes for Metal

A Composite

The blackening of non-ferrous metals is important in the war program for many reasons, including reduction of reflectivity, increase in corrosion protection, chemical non-reactivity, identification, and as a base for paint. Walter R. Meyer (*Proceedings* of the American Electroplaters Soc., 1943, pp. 90-92) gives several methods.

Nickel is usually blackened by the deposition of black nickel or black chromium. A typical black chromium formula is: Chromic acid, 47 oz. per gal.; barium carbonate, 0.67 oz. per gal.; acetic acid, 0.8 oz. per gal.; room temp.; 1000 to 2000 amp. per sq. ft. Cooling is required.

Nickel may be blackened directly with a solution containing: potassium sulfocyanide, 0.07 oz. per gal.; sulfuric acid, 0.67 oz. per gal.; hydrogen peroxide (30%), 3.4 fl. oz. per gal.; pH, 1.2. Zinc or copper may be deposited on nickel and subsequently blackened.

To deposit an adherent film of zinc or copper on nickel, Wood's nickel strike should first be used. This consists of a 30 sec. to 2 min. strike at 25 to 100 amps. per sq. ft., at room temp., in a solution containing 32 oz. per gal. of nickel chloride and 1.5 pints per gal. of concentrated hydrochloric acid.

Cadmium must be blackened by using solutions that deposit some other black metal, oxide, or salt. The following solution will produce brownish black coatings on cadmium: Copper sulfate, 2 oz. per gal.; potassium chlorate, 3 oz. per gal.; sodium chloride, 3 oz. per gal.; temp., 140 to 200 F.

High chromium and high nickel iron alloys (*e.g.* stainless steels) are usually difficult to blacken directly, although a patent for direct blackening has been awarded. The methods outlined for nickel may be used.

Aluminum is usually blackened by dyeing an anodized film. There is a commercial process in which an immersion zinc deposit is subsequently blackened with a molybdate solution.

Blackening Zinc

Since almost all salts of zinc are colorless, the formation of a black color on zinc requires the deposition of a black film. Black nickel may be electrodeposited or deposited by simple immersion. White basic salts of zinc sometimes spot the coatings.

Buffered molybdate solutions are widely used for blackening zinc. A pH range of 8.5 to 9.5 is used, and black coatings are produced in 1 to 5 min. in solutions operated from room temp. to 200 F. The zinc surface must be clean.

Copper and high copper alloys are usually blackened with sulfides. Unfortunately, sulfide finishes have poor adhesion and ductility, and are not very stable. Several processes are available for blackening of copper by production of cupric oxide in alkaline oxidizing solutions.

A solution of potassium hydroxide and potassium persulfate has been used and gives an adherent velvety black oxide finish, but the bath is expensive and short lived. The author has developed a stable

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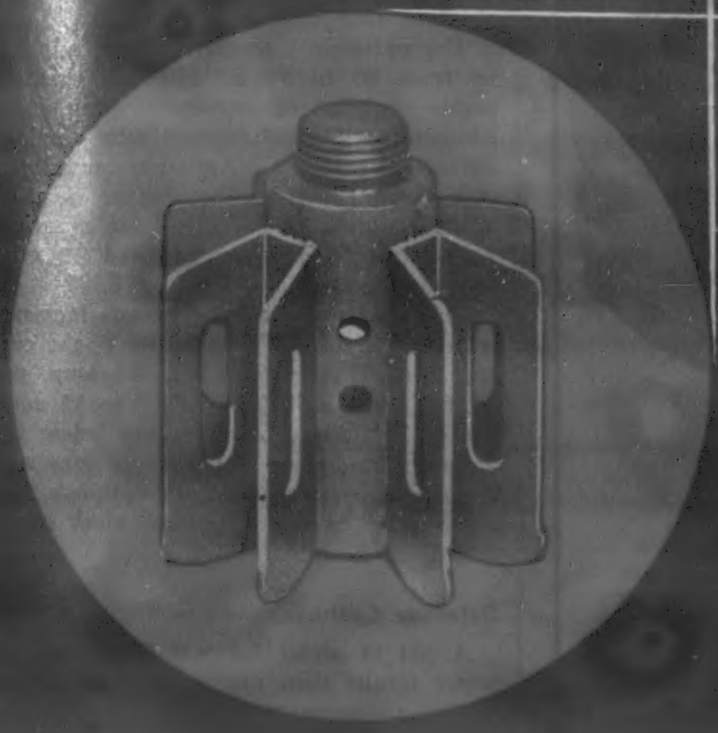

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The "Lancaster" is the only mixer that provides the two important factors for precision: (1) counter-current mixing (2) balanced mulling action. These combined actions are intensively applied on a horizontal plane. No "dead spots" are created . . . the tendency toward separation between heavy and light particles is avoided.

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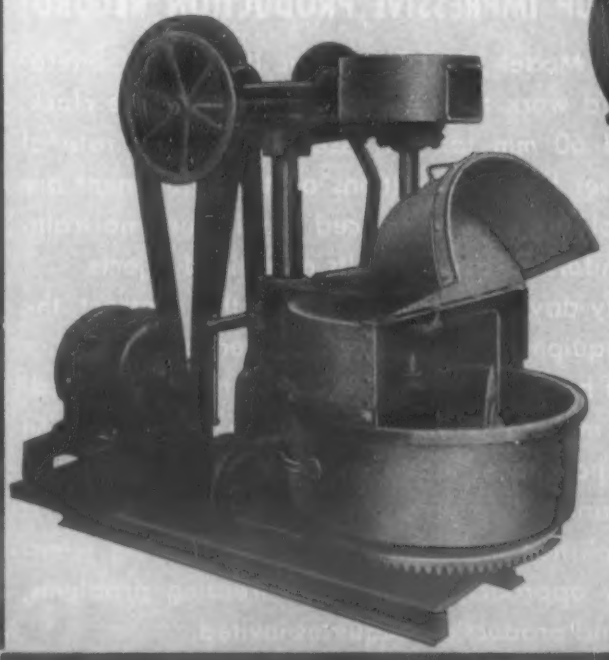
Illustration shows how material is conveyed by clockwise rotation of mixing pan and deflected by stationary side wall plow into the path of counter-clockwise rotating plows and muller (or mullers) which are established off-center of pan diameter.



"Lancaster" Mixer, Symbol SKG. Closed pan type, fitted with liftable mixing head and demountable pan.

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solution for direct oxidation of copper and its alloys, which has been widely accepted.

The velvety black coating produced is an excellent base for paint, oil or wax finishes. It has 20 hr. salt spray resistance, and oiled coatings have withstood over 200 hr. salt spray without formation of green corrosion products.

Brass containing more than 65% Cu can be blackened like copper. Another method involves anodic treatment of the brass in a strong caustic soda solution. A generally used method is the so-called "copper carbonate-ammonia" method. This produces a black film of cupric oxide, which has a bluish cast.

A typical formula is: Copper carbonate, 1 lb.; ammonium hydroxide, 1 qt.; water, 3 qts. Use at room temp. to 175 F. The work should be clean, preferably bright dipped, before treatment.

Black Nickel Plating

J. G. Poor *(Metal Finishing,* Vol. 41, Nov. 1943, pp. 694-696, and Dec. 1943, pp. 769-771) places black nickel plating solutions in two classes. In one type, the bath is strongly alkaline and contains arsenic, sodium cyanide, nickel, zinc, and sometimes ammonia. The second type is an acid bath containing a sulfocyanide, nickel, zinc, and an ammonium salt.

The arsenic type bath is not recommended because of its poisonous nature and the possibility of formation of the very poisonous gas, arsine, during operation.

The second type of bath, which was selected for further study in this investigation, has the following composition: Sodium sulfocyanate, 2 oz. per gal.; zinc sulfate, 5 oz. per gal.; nickel ammonium sulfate, 6 oz. per gal.; nickel sulfate, 10 oz. per gal. Conditions studied included temperature, agitation, time, current density, pH, effect of a buffer, and effect of ammonium salts.

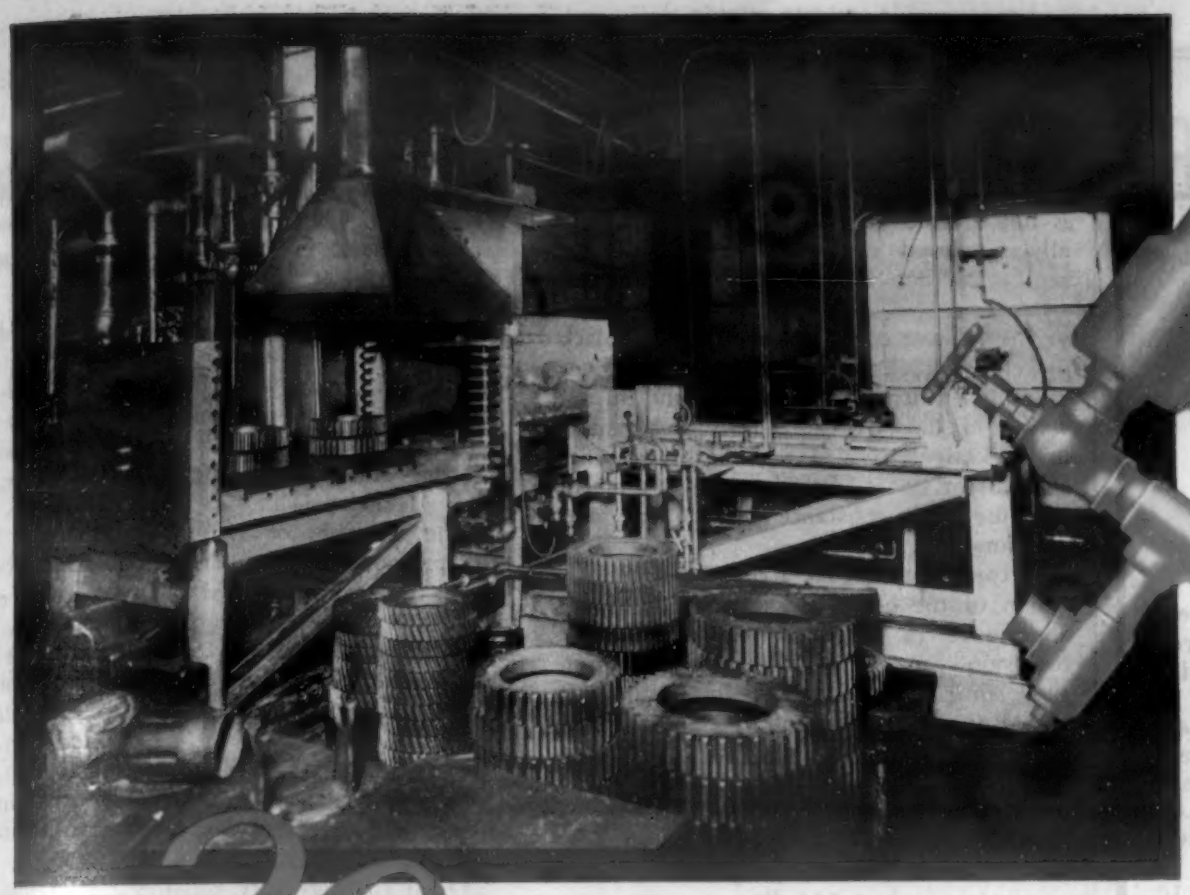
The optimum temperature was found to be from 80 to 97 F., although this depends on current density. Gray, nonadherent, or burned deposits were obtained outside this range. Agitation caused pitting, found later to be due to aeration of the solution as a result of the agitation. A lustrous black color required 30 min. for development at 85 to 90 F.

The permissible current density increases with temperature. Thus, at 90 F. the current density range is 1.5 to 4.5 amp. per sq. ft., while at 120 F. it is 3 to 13 amp. per sq. ft. At current densities below the optimum range the deposits are gray and at current densities above the optimum they are burnt. At 120 F. a good black is obtained in 10 min.

Defective Coatings

A pH of about 5.1 was found to give better results than higher values. At the higher operating temperatures and at pH values above 5.1, a tendency to obtain white specks on the deposits was noted. These specks were assumed to be basic zinc products. When 4 oz. per gal. of boric acid was added to the formula it was found that the optimum pH range was 4.4 to 5.5.

Baths operated without any ammonium salt gave gray or loosely adherent deposits,



● *(In red)* The first automatic proportioning equipment, developed by Surface Combustion.

● *(Left)* Charge end of modern gas carburizing unit, heated by radiant tube heating elements and utilizing a prepared gaseous atmosphere.

30 years OF CONTINUOUS HEAT TREATING PROGRESS •

● SINCE 1914, when Surface Combustion developed the first automatic proportioning equipment for the mixing of air and gas, the company has maintained a *continuous* program of research. This has brought to industry many basic developments in equipment, and the burning of gases, and in the application of the products of combustion to the heat treatment of metals—both ferrous and non-ferrous.

These Surface developments have proven practical because the very concept of each has come from research in metallurgy. Examples such as (1) gaseous atmospheres, based upon the combustion and chemistry of gases, (2) the radiant tube heating element, (3) the application of convection heating, (4) the utilization of alloys in moving mechanisms are some of the things that have been substantial contributions to the industry.

These are *"tools of tomorrow"* in the hands of Surface Engineers. And, with these tools are the years of specialized experience so necessary for a full understanding of the ever expanding needs of an aggressive metal industry.

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- **Lunke-Rite**—an extremely effective exothermic, powdered compound for the control of piping in steel ingots poured *with or without*, hot tops; and in steel castings. It increases ingot yield considerably. The additional heat created has a beneficial effect on quality of steel by reducing rate of cooling in center section of ingot, which has been found to prevent internal cracks and laminations. This fact is especially important for large forging ingots.—Also used for fitting ladle stopper into nozzle;—as cover on steel in ladle where duplexing or reladling is practiced;—as cover on hot metal being transported a distance from blast furnaces;—etc.—LUNKE-RITE is available in grades to suit various needs. Information upon request.

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- **Rite-Moldcote**— for steel ingot molds—can be easily sprayed and is economical to use.

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and considerable cathode gassing was noted.

Substantial thicknesses of uniform lustrous black nickel can be obtained. Some of the deposits were over 0.005 in. thick. In most cases, this thickness is impractical because the coating is brittle and cracks with the slightest flexing. This effect is not noticed with the thin deposits usually produced commercially. Thin deposits do not have much corrosion resistance.

The relative corrosion resistance of black nickel on steel, and of black nickel over cadmium, zinc, cyanide copper and nickel was studied. Exposure tests were made in the salt spray, in a humidity cabinet and out of doors. Black nickel on nickel had the best resistance to spotting and discoloration.

A copper undercoat accelerated the corrosion of the black nickel, and led to the appearance of larger amounts of white corrosion products. Zinc and cadmium gave similar results, especially in the salt spray, probably by corroding themselves.

Analysis of some deposits showed the presence of sulfur, nitrogen, carbon, nickel and zinc. Some of the nitrogen is present as ammonia, which is evolved slowly from fresh deposits at room temperature and is rapidly evolved at 350 F.

Plating Bath Variables

A study undertaken to find the optimum values of variables in black nickel plating is reported by W. E. Moline *(Proceedings* of the American Electroplaters' Society, 1943, pp. 21-23). The type of bath containing nickel sulfate, ammonium sulfate, sodium sulfocyanate, and zinc sulfate was used in this work.

As a starting point, an operable bath was used and the concentration of each component was varied in turn to get its optimum value. Using the optimum bath composition thus found, operating variables, namely pH, temperature and current density, were next studied.

Following are the optimum concentrations and operating conditions thus determined:

Bath Components	Suitable range	Optimum value
Nickel sulfate ($NiSO_4 \cdot 7H_2O$)	to 15 oz. per gal.	10 oz. per gal.
Ammonium sulfate $(NH_4)_2 SO_4$	4 to 6 oz. per gal.	5 oz. per gal.
Zinc sulfate ($ZnSO_4 \cdot 5H_2O$)	4 to 7 oz. per gal.	4 oz. per gal.
Sodium sulfocyanate (NaCNS)		2 oz. per gal.
pH	5 to 6.2	5.6
Current density	0.75 to 2.25 amp. per sq. ft.	1.5 amp. per sq. ft.
Temperature	60 to 75 F.	70 to 75 F.
Agitation	none	none

High nickel sulfate concentrations result in gray, metallic colored deposits. Ammonium sulfate appears to be the most critical constituent. Low concentrations result in smutty, dull, non-adherent deposits. More than 6 oz. per gal. precipitates from solution.

Low zinc sulfate concentrations cause the deposits to have a gray metallic appearance. Too high a concentration results in a lowered solubility of ammonium sulfate. A low sodium sulfocyanate concentration results in extremely dull deposits, while high values lead to poorly-adherent, striated deposits.

Low pH or current density leads to dull deposits, and high current density results in milky deposits. Elevated temperatures cause deposits to have a metallic appearance. Agitation leads to the formation of a cloudy film on the cathode.

Finishes for Steel

Black oxide finishes on steel, produced in high-boiling caustic solutions, have recently had a wide acceptance in both military and civilian applications. They are described by Jerome Black *(Monthly Review* of the American Electroplaters' Society, Vol. 31, Feb., 1944, pp. 131-140).

The shortage of critical materials and the promotion efforts of various manufacturers of proprietary salts has led to the expanded use of this type of finish.

Recent ordnance specifications have correctly evaluated the corrosion resistance of the coating by calling for a standard salt spray test of one-half hr. on unoiled coatings and two hr. on oiled coatings. Outdoor exposure tests normally give rust in from four to seven days in normal temperatures and humidity.

Oiled coatings vary considerably in outdoor exposure, but in general, differences between black finishes have little effect compared with differences between oils.

Thicknesses of normally applied coatings are about 30 to 40 millionths of an in. Comparative tests of coatings have been almost non-existent.

A test that shows promise is the use of a sulfuric acid solution containing copper sulfate. A drop of the solution is placed on the surface and the time required for the appearance of a copper spot is noted.

Although molten salt baths for producing black oxide finishes have been used a comparatively long time, the present type of blackening solution is largely a development of the last few years. However, in isolated instances such baths were used during the first World War and at intermediate times.

Good results with this type of bath require an understanding of operating conditions. Parts should be completely clean before blackening. If the cleaner is too highly alkaline, some of the parts may fail to blacken.

Temperature control is most important. The temperature must usually be kept constant within a range of about two degrees. The range is wider with a new solution or one to which a large salt addition has just been made.

For single tank processes on most low

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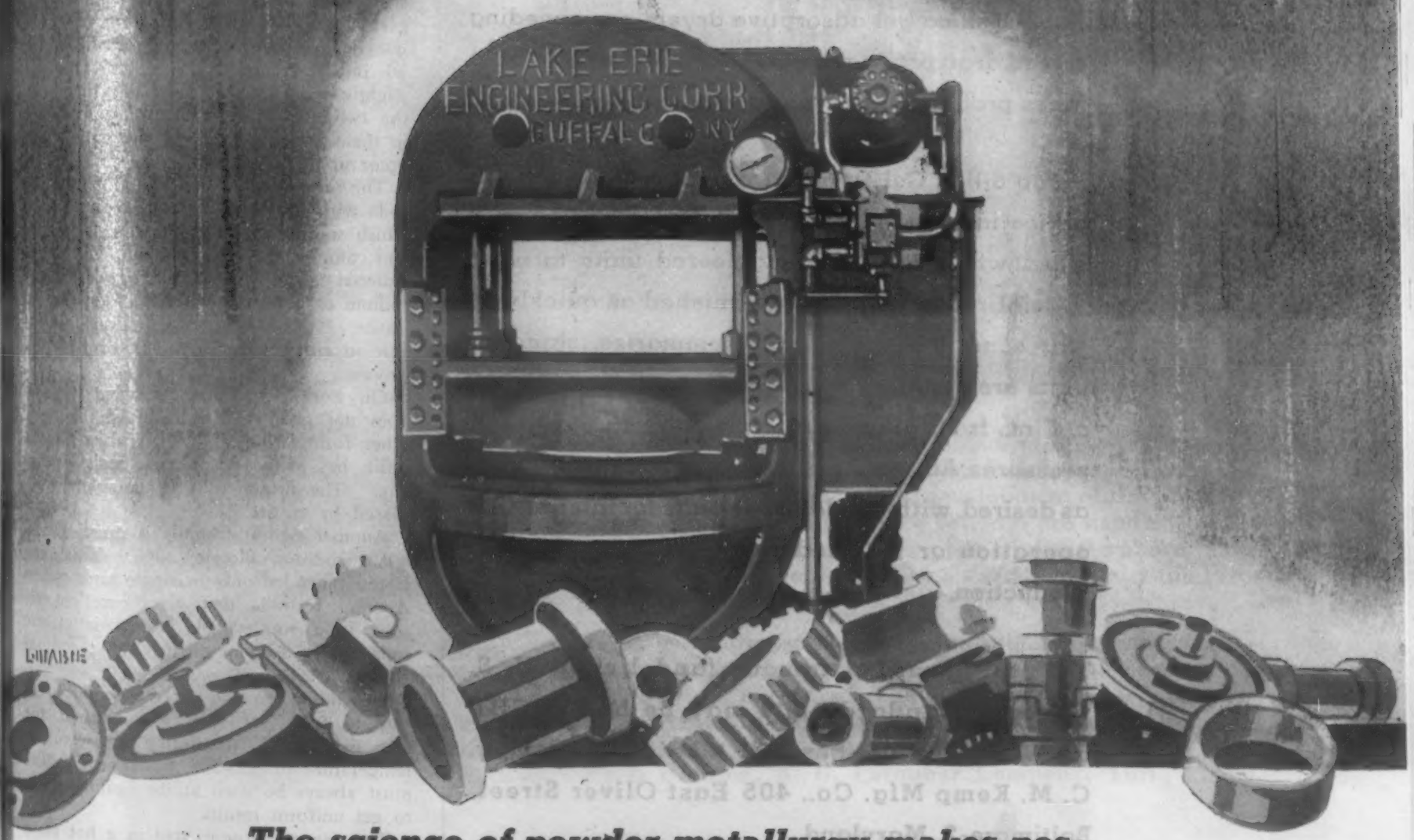

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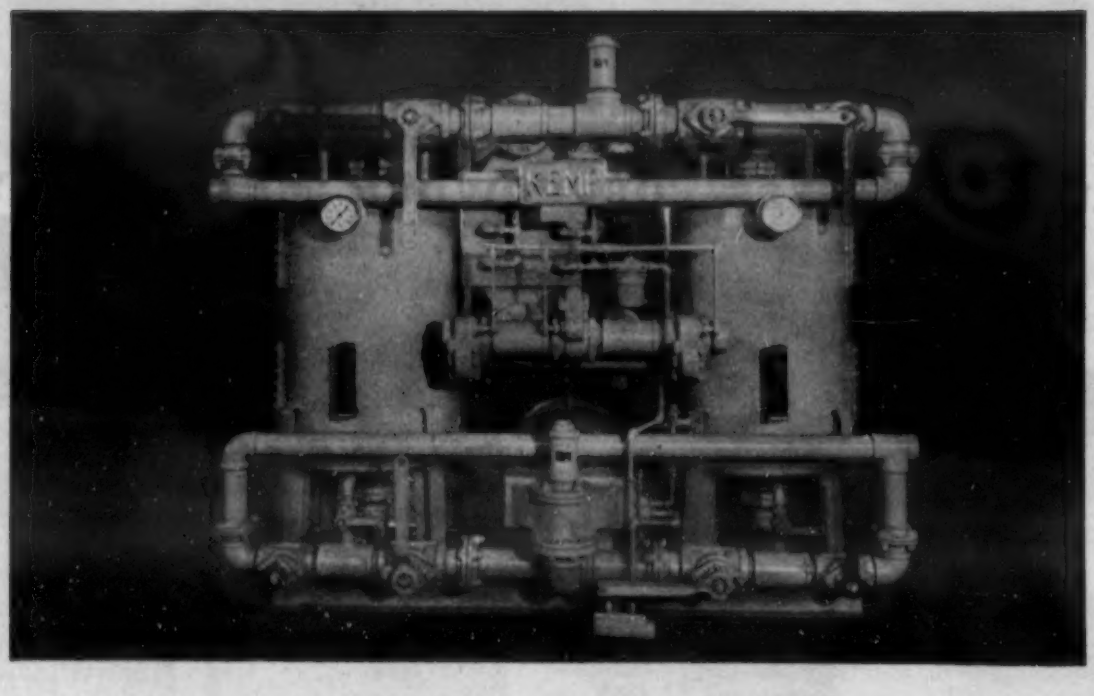

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*Except the dehydration of foods, which is a different problem altogether.

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carbon steels, the operating temperature is usually 295 to 298 F. Temperatures below 290 F. will not usually give a satisfactory black, while above 300 F. red oxide is formed.

Alloy Steels

Alloying constituents, such as nickel or chromium, raise the blackening temperature. Thin sections, as wire and thin sheet, blacken at lower temperatures than normal sections, such as stampings or machined parts.

Because of the desire to process different types of parts at the same time, various addition agents have been added to prevent red oxide formation. Cyanides are the most successful.

Operating characteristics of two-tank processes are similar to those for single tank. The first tank is operated well below the temperature of red oxide formation, 285-295 F., and the second tank at 295-305 F. The higher temperature can be used without red oxide formation when it follows the treatment at the lower temperature in the first tank. More uniformly black finishes can sometimes be obtained with the two-tank process.

Immersion time is important. In a single tank process, although 10 min. will give a good black, the corrosion resistance does not reach a maximum until 20 to 30 min. immersion. It then falls off slightly with longer immersion time. In the two-tank process with only five min. in the first tank, red oxide formation may occur in the second tank.

The salts consist of 50 to 80% caustic soda with the balance oxidizing agents, of which sodium or potassium nitrate, nitrate and chlorate are most common. A typical material might be: Caustic soda, 66%; sodium or potassium nitrate, 17%; sodium nitrite, 17%. This composition is suitable in either the single tank or two-tank process.

On work-hardened and passive steels it does not give as black a finish as some other formulations, but the lighter-colored finish has as good corrosion resistance as any. The nitrate may be completely replaced by nitrite.

Another typical formula is caustic soda, 80%; sodium chlorate, 20%. This type is recommended only in single tank cycles. Another formula that gives excellent results in a single tank process is caustic soda, 70%; sodium nitrite, 29%; sodium chlorate, 1%.

Depending on the exact formula used, 7¼ to 8 lb. of salts are required for each gallon of final solution for a boiling temperature of 295-298 F. The solution must always be used at the boiling point to get uniform results.

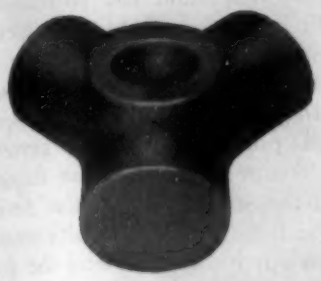
The use of chromic acid in a hot rinse following a cold rinse improves the corrosion resistance of the finish.

Thermit Welding

Condensed from "Steel"

Thermit welding, long used for repair work, is now finding increasing application as a regular production process in the fabrication of heavy assemblies. In making

28% VIRGIN METAL SAVED WITH THIS FARQUHAR HYDRAULIC PRESS

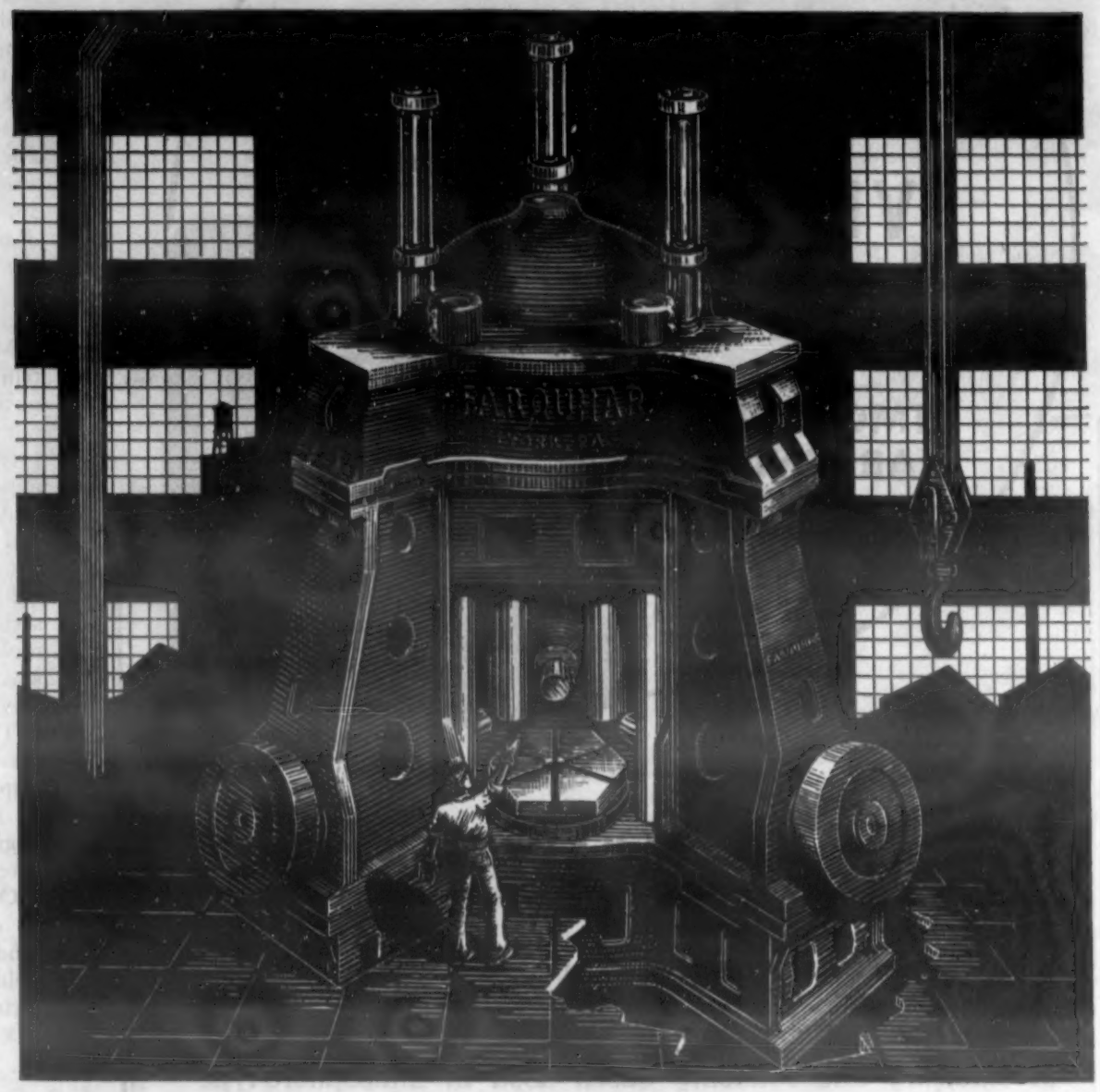


This propeller hub forging weighs approximately 372 pounds. When machined to form the finished hub shown in the bottom illustration, the average cutting loss of virgin metal is 316 pounds.

To produce the same hub this forging weighs approximately 267 pounds, 105 pounds less than the top forging. Out of a ton of virgin metal seven hubs can be forged instead of five. 40% more hubs.

By proper forging and extrusion in the 7200 ton Farquhar Hydraulic Press the forging shown in the second illustration takes this form, ready for machining and still weighing only 267 pounds.

Here's the finished product. Weight approximately 56 pounds. The identical propeller hub is obtained by forging and extrusion, then machining of a 267 pound forging, as from direct machining of a 372 pound forging. Thus 28% in metal is saved for other hubs . . . plus the added advantage of fewer rejects and less machining time.



You may have a similar metal working problem to this—an outstanding example of how critical metal can be saved with proper hydraulic press equipment. Study the step by step development of the propeller hub forging as shown on the left. These forgings are handled on the 7200 ton forging and extrusion hydraulic press illustrated above. Consider your own production problems. Can a Farquhar Hydraulic Press lick these problems for you?

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a ship stern-frame, for example, the parts to be welded are aligned and a parallel-sided gap is cut by an acetylene torch at the point where the weld is to be made.

The width of the gap depends upon the size of the section to be welded. Then a wax pattern of the shape of the weld and collar around the weld is formed. A mold-box is built around the pattern and rammed with a special molding material. Gates and risers are arranged suitably.

Sections to be welded are preheated through heating gates by means of a specially designed preheater burning kerosene atomized by compressed air. The flame is applied until the sections attain the desired degree of "redness," and, simultaneously, the wax pattern is burned out and the mold thoroughly dried. The heating gates may be closed with an iron plug or a sand core.

Meanwhile, the cone-shaped crucible containing the thermit is placed in a pouring position directly over the mold. The thermit is "fired" only a short time before preheating is completed, and the molten metal is tapped immediately thereafter.

As soon as the slag is completely solidified after pouring, the steel plates forming the mold-box are removed. The baked mold material is left in place until the welded section has cooled properly. Then the mold material is stripped off and the gates and risers removed. The thermit collar may be machined off, if necessary.

This type of construction is being used for Victory, Liberty, and other types of ships. It has been tested and approved by American Bureau of Shipping, Lloyd's Register of Shipping, and other inspection bureaus.

Other uses of the process are fabrication of crankshafts, freight car sections, and bending rolls for ship plates. Where many welds, all alike, are required, permanent patterns are made up in place of the usual wax patterns.

—*Steel*, Vol. 114, Feb. 14, 1944, pp. 102-103, 134.

Tinning by Ultrasound

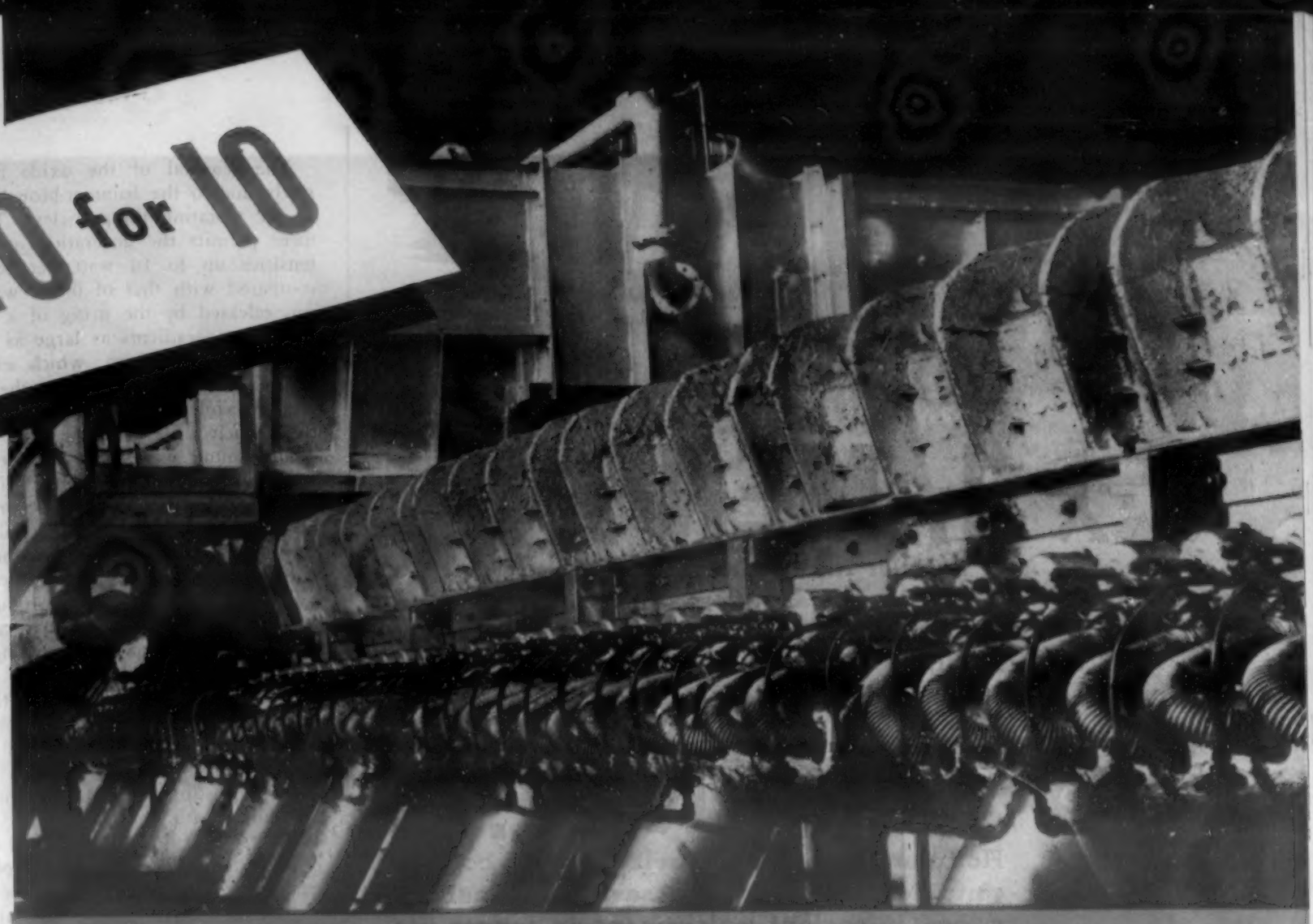
Condensed from
"ATZ Automobiltechnische Zeitschrift"

A thin oxide film on the surface of light metals greatly impedes the coating with other metals. Use of ultrasound waves makes possible the tinning of thin aluminum sheet. The sheet is dipped into a bath of molten tin, at the same time contacting the sheet with an ultrasound generator.

The vibrations transmitted to the aluminum are, in turn, transmitted to the tin film surrounding the sheet. The enormous accelerations and decelerations thereby imparted to the tin particles remove the adherent layer of oxide, its place being taken by a layer of tin intimately bonded with the virgin aluminum.

Vibrations with a frequency of 12,000 per sec. are inaudible. With a velocity of sound in air of 330 m. per sec., the waves comprise a range of lengths of 16 mm. to 0.005 mm.; in liquids, a velocity of 1200 m. per sec., with lengths ranging from 60 to 0.002 mm.

10 for 10



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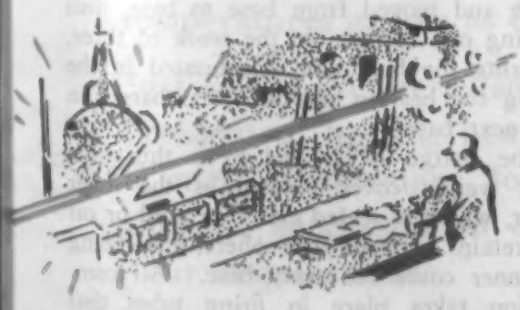

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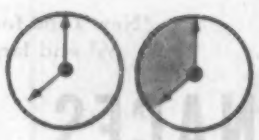

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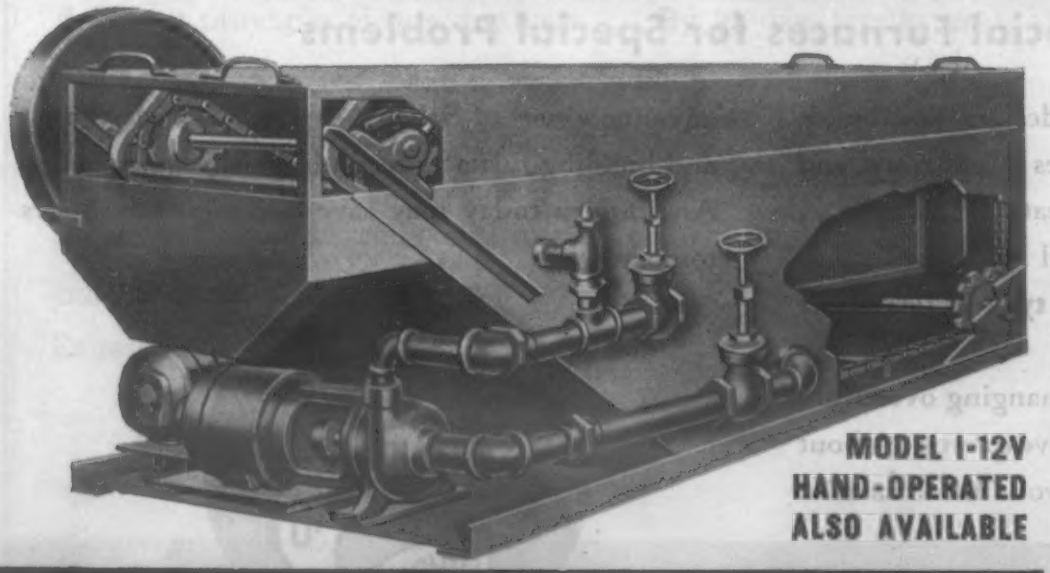

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The removal of the oxide film is directly due to the hammer-blow-like impact of the vibrating tin particles. The equipment permits the generation of sound intensities up to 10 watt per sq. cm., as compared with that of 0.001 watt per sq. cm. released by the firing of a cannon.

Pressure gradients as large as 10 atmos. per mm. are set up, which explain the enormous accelerations given the tin particles, so violent that they may disintegrate the particle.

Ultrasound waves can also be used for producing an extremely fine dispersal of solid particles in liquids — or mixtures of ordinarily immiscible materials. In this way, a self-lubricating bearing bronze containing 25% graphite in homogenous mixture with the metal can be produced.

Generation of the waves is carried out by a.c. of a frequency equaling that of the ultrasound waves to be produced. This current is passed through the coil of a solenoid, the core of which consists of a short piece of tube, 80 Ni and 20% iron alloy.

By adjusting the current to produce resonance with the mechanical frequency of the core, the contraction and expansion of the core under the influence of its magnetization can be greatly increased.

—A. E. Thiemann. *ATZ Automobiltech. Zeitschrift*, Vol. 45, Dec. 25, 1942, p. 668; as translated in *Engineers' Digest* (American) Vol. 1, Jan. 1944, p. 88.

Bell-Type Annealing Furnaces

Condensed from "Industrial Gas"

Makers of steel sheet, strip and tin plate have largely converted equipment to alloy radiant tube heating in bell-type annealing furnaces, using low cost fuel gas. There are now over 1500 such units in use, though the process started as recently as 1934.

The furnace can be picked up with a crane and moved from base to base, thus making one furnace do the work of three, utilizing the heat that is saturated in the lining for heating up the next charge on the next base.

The charge is covered by a thin-gage, light weight cover, known as the inner cover, which is sealed either in sand or oil and retains a special atmosphere, there being an inner cover for every base. All combustion takes place in firing tubes that usually contain 25 Cr, 12% Ni, mounted in the side wall of the furnace.

They are fired at the bottom so that major heat release is toward the bottom of the charge. Products of combustion pass up the tube and out its upper end, discharging into the room. Some of their heat is absorbed by refractory corebuster pieces, which produce a reradiation surface.

They are held in place with alloy links fastened to a hook at the top of the firing tube. The firing tubes are ignited by an electric system that provides a transformer

(Continued on page 1226)

Study this war development in

ELECTRIC CONTACT HEAT

... it may answer your problem

● Hundreds of thousands of H. & A. Electric Contact Heat Units—in different shapes, sizes and capacities—are keeping machine guns firing, storage batteries operating, in frigid temperatures as low as 65° F below zero.

Just as our engineers solved, for the first time, the tough problem of heating heavy steel mechanisms by means of a small, light-weight, low-wattage heating unit, so might they be successful in engineering special units to meet *your* requirements.

We invite you to submit any such problem to us.

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Manufacturing Co. Inc.

PLANTS IN BINGHAMTON AND BUFFALO, N. Y.

send for this New BOOKLET

It shows how H. & A. units can be engineered in nearly any size, shape and capacity—to maintain heat of exact temperature in mechanical or electronic devices or at critical steps of mechanical or chemical processes.

Write H. & A. Engineering Department
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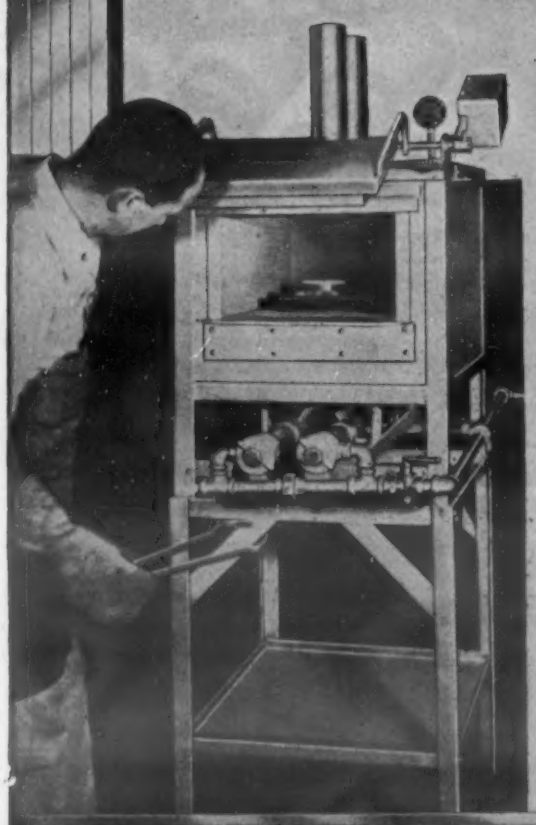
Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

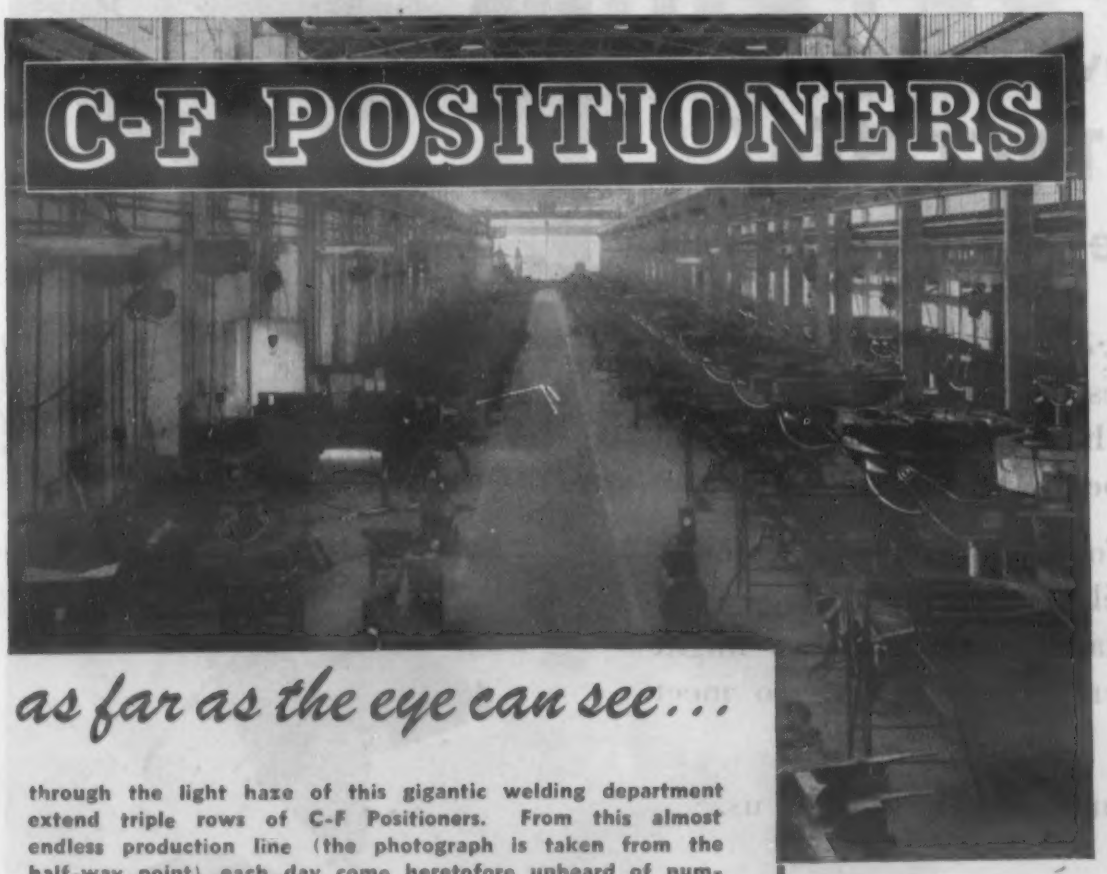
We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

113 Astor St., Newark, N. J.

C-F POSITIONERS



as far as the eye can see...

through the light haze of this gigantic welding department extend triple rows of C-F Positioners. From this almost endless production line (the photograph is taken from the half-way point) each day come heretofore unheard of numbers of fabrication with all seams, joints and unions strongly and smoothly welded "downhand".

There are no handling problems or delays, for on C-F Positioners each welder positions his weldment for succeeding welds with a pushbutton control . . . can rotate it at any desired speed (360°) or tilt it to any angle up to 135° beyond horizontal.

Write for Bulletin WP-22

Cullen-Friestedt Co.

1314 S. Kilborun Ave
Chicago 23, Ill.

for every two tubes and a high tension transformer for every tube.

Air and gas travel up the tube, strike the electric spark, ignite, causing combustion to take place off the end of the burner, completed before the gas has reached the lowest corebuster link. All types of natural and manufactured gases can be used, including refinery-developed gases, such as propane and butane, and low B.t.u. fuels, such as anthracite and coke producer gas, with even vaporized oil.

Gases Circulated

In cylindrical bell-type furnaces or on rectangular furnaces where circular inner covers can be used, such as for annealing eight stacks of tinplate coils, a recirculating fan is used at the bottom of each stack so that gases under the inner cover may be moved rapidly to produce fast heating, fast cooling and good temperature distribution.

These fan blades and shafts contain 35 Ni, 15% Cr, and rotate at 1800 r.p.m. for 60 cycle current to produce circulation of 7500 c.f.m.

In a typical installation, the fuel gas and air are pumped up to the proper pressure and introduced in the correct ratio which, for coke oven gas or city gas, is about two and a half parts of air to one of gas, and for natural gas is six and one-half parts of air to one of gas. For protective atmospheres, products of combustion are used that analyze 4½ CO_2 8 to 10 CO and 10 to 12% H, balance nitrogen.

Water vapor is removed to reduce their dewpoint to 40 F. for ordinary low carbon steel products; for higher carbon, different analyses of gas and much lower dewpoints are needed.

In certain installations charges as high as 20 tons of No. 52100 seamless pierced tubing have been spheroidized; 25 tons of tool steel and 15 to 20 tons of cold rolled bars at one time. The system can be used for the malleabilizing of iron castings.

For the radiant burner tubes, a wall thickness of ⅛-in. is found to be strong enough in most cases. One great advantage of the system is that the heat can be applied precisely where it will do the most good.

—J. L. Whitten. *Ind. Gas*, Vol. 22, Mar. 1944, pp. 13-16, 34-35.

Machining Zinc Alloys

Condensed from "V. D. I. Zeitschrift"

Chippability is defined as a collective term for all material properties that exert a favorable or unfavorable effect in the formation of chips in machining. These properties are classed in four groups:

(1) *Life of tool.* As cutting temperatures are very low for zinc alloys, temperature is no factor for the loss of cutting power. The latter is mainly due to the wearing attack of the alloy on the tool, which leaves on the front (cutting) side of the tool a distinct mark the breadth of which increases with increasing cutting time. Curves have been derived for a

"AN LST HAD TO BE READY WITHIN 96 HOURS"

PENNSALT CLEANER #23

helped finish the job in 48

Here's the story as our own technician tells it:

PROBLEM: The subject company makes LST (landing ships for tanks). Deck plates are made at a distant plant and, to prevent rusting, are painted with a zinc chromate base in a bakelite or glyceral phthalate vehicle. The shop men had great difficulty in stripping this paint from the plates and the chief chemist called on us because he believed we might have had some experience. It was 11 a.m. Friday when we were called in. *He told us that one of the ships, which still needed deck plates installed, had to be complete for a trial run within 96 hours.*

EQUIPMENT USED: As speed was essential, a special wooden tank was built and lined with sheet metal.

METHOD USED: A solution of Pennsalt Cleaner #23 was made up and heated to 212° F. The deck plates were immersed for 15 minutes, rinsed and dried.

RESULTS: At 11 a.m. Sunday (exactly 48 hours after we were called in) enough plates had been stripped for four LST's and all necessary plates were installed in the ship required for test run.

REMARKS: Customer was greatly pleased. Pennsalt Cleaner #23 was the only satisfactory stripper they had tried. They were pleased too because the job saved 48 hours.

Let our technical staff consult with *you*. Perhaps one of this famous family of Pennsalt Cleaners can help save time, material or labor on your specific metal cleaning problem. Write fully to our Special Chemicals Division, Dept. MA.

SPECIAL CHEMICALS DIVISION PRODUCTS

Acid-Proof Cements • Alkali-Proof Cements • Lead Fluoborate Concentrates • Fluoboric Acid • Acid, Alkali and Solvent-Emulsion Type Cleaners • Paint Strippers.

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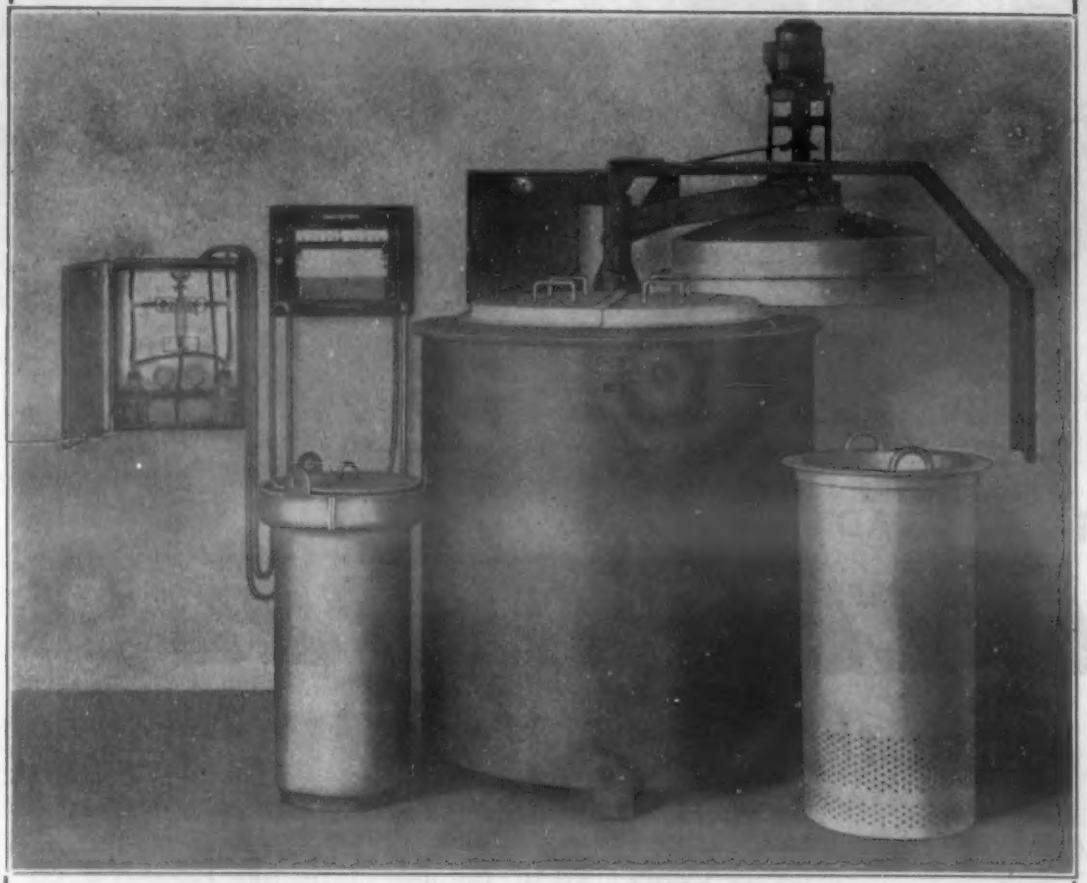
Cutting **NITRIDING TIME CYCLES**

with

"AMERICAN" DUAL PURPOSE FURNACE



Model NA Air Tempering Furnace With Nitro Attachments

The pressure system together with precision control of time, temperature and flow of ammonia gas are resulting in unequalled advantages to the users of "AMERICAN" Electric Nitro Furnaces, and the "AMERICAN" Electric Air Tempering Furnaces with the Nitro attachments.

ARMY E NAVY

American Electric Furnace Company

29 Von Hillern St., Boston, Mass., U.S.A.

Industrial Furnaces for All Purposes

zinc alloy, which gives the tool life for different drawing degrees of the alloy, with a sulphurized mineral oil as cutting fluid.

(2) *Cutting power.* The energy consumption for cutting can be determined from formulae, and from these measurements the most favorable angle for the tool determined. The degree of drawing of the material influences the cutting force rather irregularly, and for the above alloy was found:

Cutting force, Kg.	Degree of drawing, %
32.5	55
32	0
31.5	10
29.5	40
27	25

(3) *Surface quality.* In order to produce a high-quality surface, the cutting angle has to be such that the chips do not stick to the cutting edge. Again the degree of drawing has a noticeable effect—up to 40%, the surface quality improves in the mentioned material, and a cutting angle of 12° seemed to be the most favorable.

(4) *Chip formation.* Chips of zinc alloys can take numerous different forms, and nine characteristic forms have been distinguished that are obtained according to cutting conditions. Among them are the favorable small, gritty chips, and also the unfavorable very tough, wiry spirals that clog the machines. By rating the chips according to their "respective volume ratios" R, indicating how much more space the loosely piled chips assume as compared with the solid material (not cut), the following was found for different materials, velocity for steels and cast iron 30 m. per min., and for the other materials 100 m. per min.:

Material	Volume Ratio R	Chip Angle°
Brass Ms 58	3.18	0
Al alloy for automatic tools	3.42	0
Cast iron	6.31	12
Al piston alloy	8.26	25
Steel VCN 45	19.6	12
Al-Cu-Mg	24.25	25
Zn-Al 10-Cu 2	39.5	25
G Al-Mg-Si	39.95	25
Al-Mg	85.0	25
Al-Cu-Ni	132.0	25
Steel VCMo 135	182.5	12
Steel VCN 35	295.0	12
G Al-Si-Mg	1000	25
Pure aluminum	1000	25

The smaller the number the better, and the easier also the removal of the chips; for automatic machine tools, the materials should have an R about 15, and not exceed 50. By selecting cutting conditions correctly, R could be reduced to 2.6. The degree of drawing did not seem to have any influence here.

—W. Bieling. *Z. Ver. deut. Ing.*, Vol. 87, July 24, 1943, pp. 462-465.

—Gives the necessary HIGH STRENGTH without affecting the metals joined!

This spring tube body was formerly made by high temperature brazing—but the high heat adversely affected the temper of the steel. EASY-FLO, with its low working temperature of 1175°F, ended this difficulty—and produced stronger joints as well.

Also, production was increased by preplacing EASY-FLO in strip form between the two parts and heating in a furnace adapted for the job. Actual brazing time is only a few minutes.

Throughout war production you'll find hundreds of similar cases where low-temperature brazing with the free-flowing, fast-acting silver alloy EASY-FLO, has solved the problem of joining metals fast, reliably and economically, without affecting their properties.

And what low-temperature EASY-FLO brazing has done on war production metal joining, it will do on peacetime metal joining. That's why it is sure to play just as big and vital a part in post-war manufacturing. That's why you want to start just as soon as you can to get the benefit of EASY-FLO speed, reliability and economy on your own ferrous, non-ferrous and dissimilar metal joining operations—and you can do it very easily.

BULLETIN 12-A WILL GIVE YOU FULL DETAILS. A copy will be sent on request. Write for yours today.

ARMY (E) NAVY
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HANDY & HARMAN

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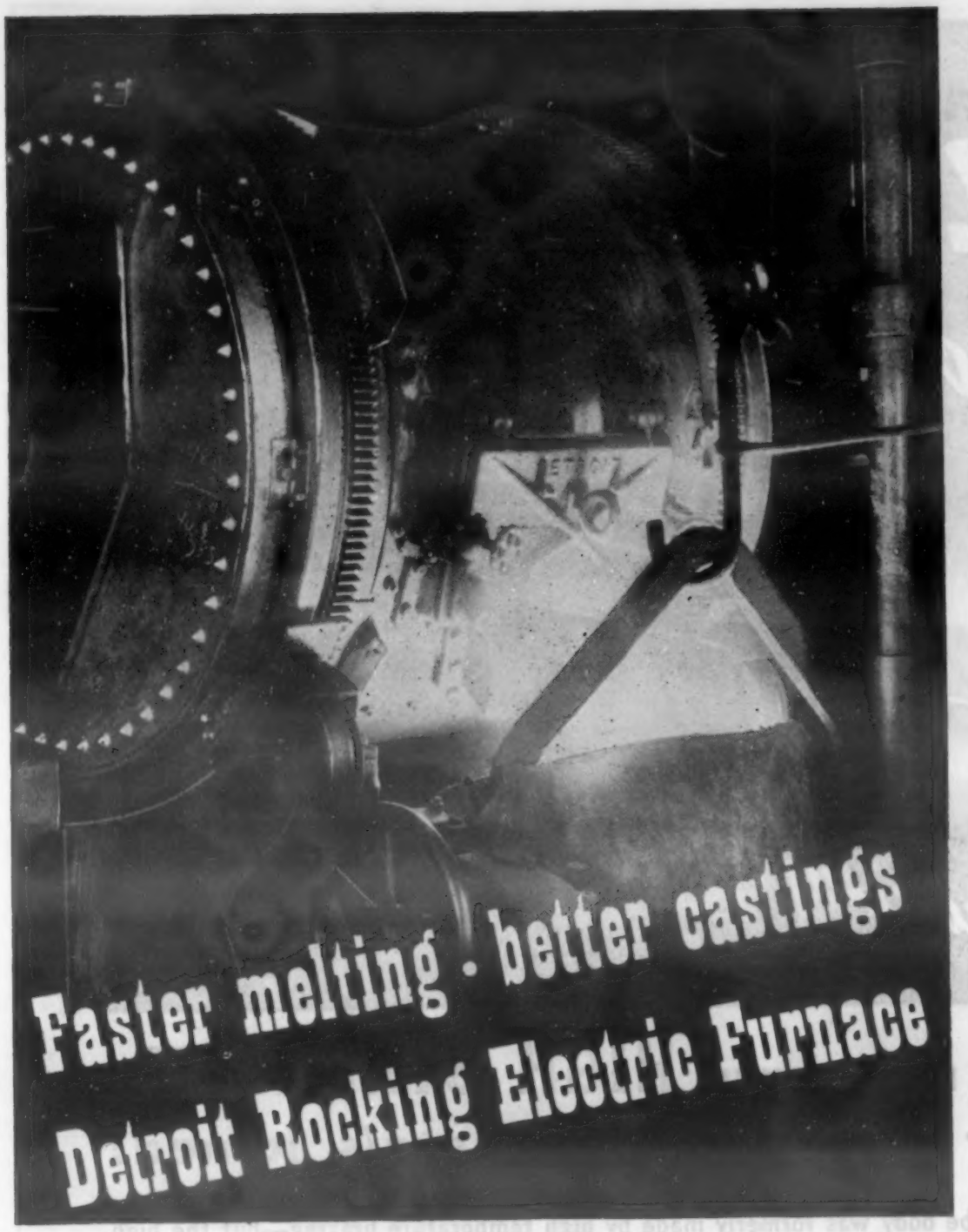
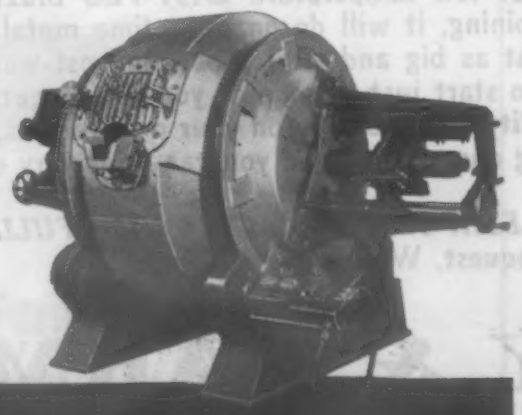
Bridgeport, Conn. Chicago, Ill. Los Angeles, Cal. Providence, R. I. Toronto, Can.
Agents in Principal Cities



When that white hot metal leaps into the ladle from a Detroit Rocking Electric Furnace you can safely bet 50 to 1 you've got a perfect heat — for precise metallurgical control of every heat is comparatively easy with a Detroit Furnace. And you foundrymen know what that means: lower metal losses, less labor, more pounds produced per man hour, a higher percentage of perfect castings of uniform quality. And as to speed, here's a fact worth noting: with a Detroit Rocking Electric Furnace you can pour as many as 8 ferrous or 16 non-ferrous heats in one eight-hour day. Each heat may be of the same, or of a different analysis. Each heat will be poured with a minimum of dirt, fumes and hard work.

From many standpoints it will certainly pay you to operate Detroit Rocking Electric Furnaces in your foundry.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

Rapid Silver Plating

Condensed from "Procedures," American Electroplaters' Society

The excellent mechanical properties of silver have suggested its use as a bearing metal, and several researches related to the use of electrodeposited silver for this purpose have been carried out.

In the present work, attention was directed toward obtaining rapid deposition of silver. A deposition rate of approximately 0.012 in. per hr. was employed.

In the experimental work, the amount and method of agitation and the current density were the same in all experiments. Plating was carried out on the inside of steel shells of approximately 3.5 in. diam. The shell was rotated around the inside cylindrical anode at a speed of 125 r.p.m.

Additional agitation was obtained by pumping the solution through the steel shell at the rate of 50 gal. per min. The cathode current density was 100 amp. per sq. ft.

At these conditions of agitation and current density, the effects of high metal content, low free cyanide concentration, alkali hydroxide concentration, temperature, and addition agents were studied.

Anodes were of 99.9% Ag, cast in either carbon or cast iron molds with a mold temperature below 700 F. at the pouring time. Anode purity was not found to be as critical as for the conventional type of bath.

The composition and operating conditions of the bath, which was found to be the best, are as follows:

Silver cyanide, 40 to 43 grams per liter;
Free potassium cyanide, 38 to 42 grams per liter;
Potassium hydroxide, 8 to 14 grams per liter;
Potassium carbonate, 45 to 80 grams per liter;
Temperature, 42 to 45 C (108 to 113 F.).

The potassium hydroxide is a fundamental ingredient, and makes possible a lower silver concentration than could otherwise be used. Concentrations of potassium hydroxide above or below the limits stated lead to rough, porous deposits. Low free cyanide is beneficial in leading to smooth deposits.

The lower limit stated is quite near to a concentration, which will cause excessive anode polarization. If the potassium carbonate concentration goes above 95 grams per liter, brittle, porous deposits result.

Temperatures below 40 C. (104 F.) cause rough, porous deposits, while temperatures above 50 C. (120 F.) cause high cyanide consumption.

Among the many addition agents tried were two sulfur compounds and several metal salts. None of them gave results of practical benefit.

Consumption of chemicals by the bath is low. For 100 lb. of silver deposited, 4 lb. of potassium cyanide, 9 lb. of potassium hydroxide, and no silver cyanide were consumed. Deposits from the bath are dense and ductile.

—R. A. Schaefer & J. B. Mohler, *Proc.*, Am. Electroplaters' Soc., June 1943, pp. 29-31.

Forty-four Giant Stainless Steel Valve Castings Produced from Lebanon CIRCLE L 22

"SIMPLY another lend-lease job," said a Lebanon foundry engineer in speaking of these 16" gate valve castings—among the largest all-stainless valve castings ever made. Big as these castings are, they give only a small indication of Lebanon's product range and of the capabilities of Lebanon Ⓛ 22.

This 18% chrome, 8% nickel alloy satisfactorily resists acetic acid, alkaline liquors, ferrous sulphate, sodium sulphate, hydrogen sulphide, acid mine waters and many other corrosive solutions at normal temperatures.

A few of the many installations to which Lebanon Ⓛ 22 has been successfully applied are: marine scuttle covers; centrifugal separator disc holders dyeing reel spider and cup rings; valves and valve trim in the chemical and process industries.

This alloy of wide use may offer a solution to one or more of *your* corrosion problems. Consider it when planning reconversion units—and talk it over now with Lebanon metallurgists and foundry engineers.

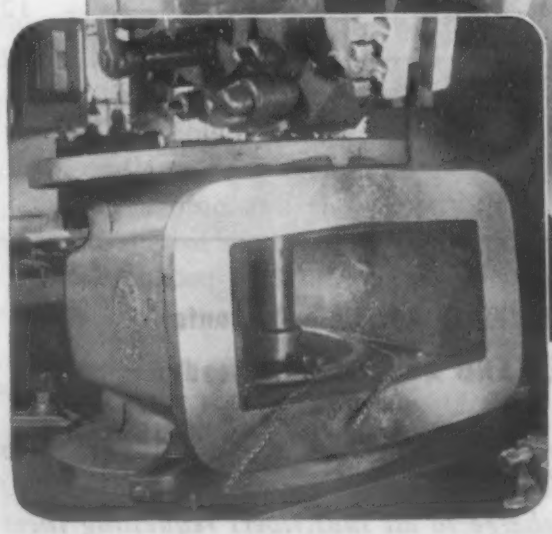
Physical Characteristics of Lebanon Ⓛ 22
(Properly Heat Treated)

	Minimum Values
Tensile Strength (lbs. per sq. in.)	70,000
Yield Point (lbs. per sq. in.)	32,000
Proportional Limit	25,000
Elongation in 2"	45%
Reduction of area	50%
Impact Value (Charpy) Room Temp.	75 ft. lbs.
Minus 150° F.	15 ft. lbs.
Brinell Hardness	140 to 175

LEBANON STEEL FOUNDRY

LEBANON PENNA.

Note the size of this 16" gate valve casting in relation to man.



Machining a Lebanon L 22 gate valve casting for lend-lease shipment—cast by Lebanon Steel Foundry for Alloy Steel Products Company.

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON CIRCLE L *Stainless and Special Alloy* **STEEL CASTINGS**

Materials and Engineering Design

4

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metal, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Address requests to Index Editor, METALS AND ALLOYS, *330 West 42nd St., New York 18, N. Y.*

Acid-Resisting Cast Iron

Condensed from "Foundry Trade Journal"

It is well established that alloys of iron and silicon containing upwards of 14% Si possess very great resistance to the corrosive attack of the mineral acids. These alloys are manufactured and sold under a variety of trade names, but are all embraced in the term "high-silicon acid-resisting cast iron."

The magnitude of boiling 20% sulphuric acid attack decreases rapidly with increasing silicon content. Above a value of 14.25% further increases in silicon do not result in proportionate increase in resistance.

The effect of boiling 70% nitric acid is not so violent, and a smaller minimum percentage of silicon can be tolerated. The diagram shows that an alloy containing 12.5% Si has sufficient resistance to boiling 70% nitric acid.

Maximum permissible penetration of 0.1 mm. per yr. is accepted for this class of material, and on this basis any alloy containing more than 14.25% Si can be regarded as having a satisfactory acid resistance.

Silicon iron of this composition will withstand successfully all concentrations of these two acids, either hot or cold or in admixture. Acid-resisting silicon iron is most easily attacked by the halogens and halogen acids. The attack of hot concentrated hydrochloric acid is appreciable, but in the cold the rate of corrosion is negligible.

The resistance of 15% silicon iron to hot hydrochloric-acid solution is increased substantially by the addition of molybdenum. The attack on silicon iron by concentrated and dilute phosphoric acids is negligible at room temperatures.

At elevated temperatures the attack by both concentrated and dilute acids was of the same order as that obtained in 20% boiling sulphuric acid. Tests carried out recently indicate that 15% silicon iron has a very good resistance to the hot acid liquors normally used in dye works. A polished test-bar immersed for 4000 hrs. in a dye liquor under factory conditions remained bright and free from any sign of corrosion.

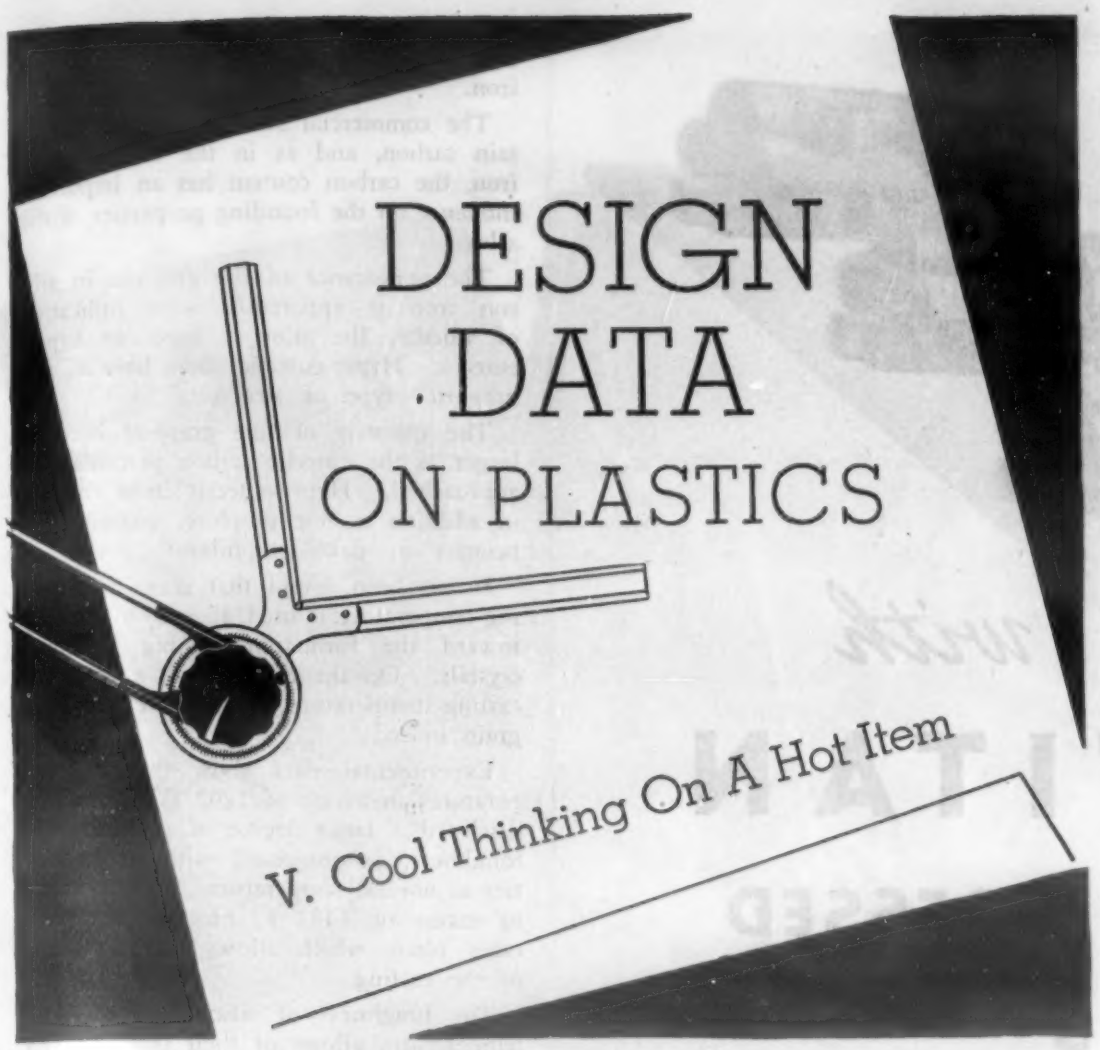
The effect of moist atmospheric conditions on silicon iron is exactly similar to that of strong acids. Below a critical percentage the alloy will rust when exposed to the atmosphere, whereas alloys of the higher silicon percentage remain quite bright and clean.

The critical percentage of silicon is rather higher than that for satisfactory resistance to 20% sulphuric acid (boiling), probably in the region of 14.7% or higher.

It is a matter of some theoretical metallurgical interest that the critical percentages of silicon in these alloys for corrosion resistance in various media should all lie within an area of uniform solid solution, up to a silicon percentage of 15.7%.

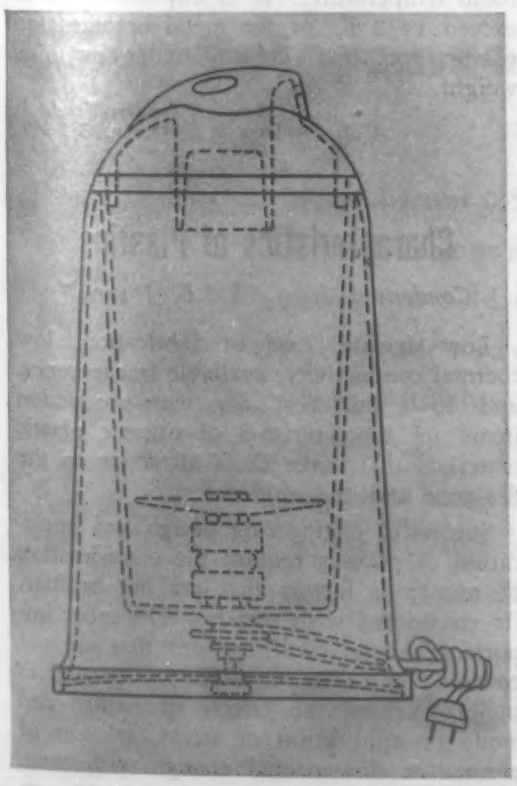
Mechanical Strength

The mechanical strength of iron-silicon alloys is lowered in proportion to the amount of silicon present. Commercial 15% silicon acid-resisting alloy of good



Most of the current plastic pieces which are of more than passing interest to design engineers necessarily come out of the "war zone". It is proper to so classify the DeVilbiss all-plastic vaporizer ... the first of its kind ... produced to combat the dangerous "bugs" of flu, pneumonia, bronchitis, etc. on the home front.

It is a piece worthy of study and explanation. The assembly consists of two shells, a cover, shield plate, assembly bolt head, and locking nut ... all molded from a Durez phenolic plastic ... heating element and a porcelain washer. Ease of moldability in this Durez phenolic made possible certain complex molding operations.

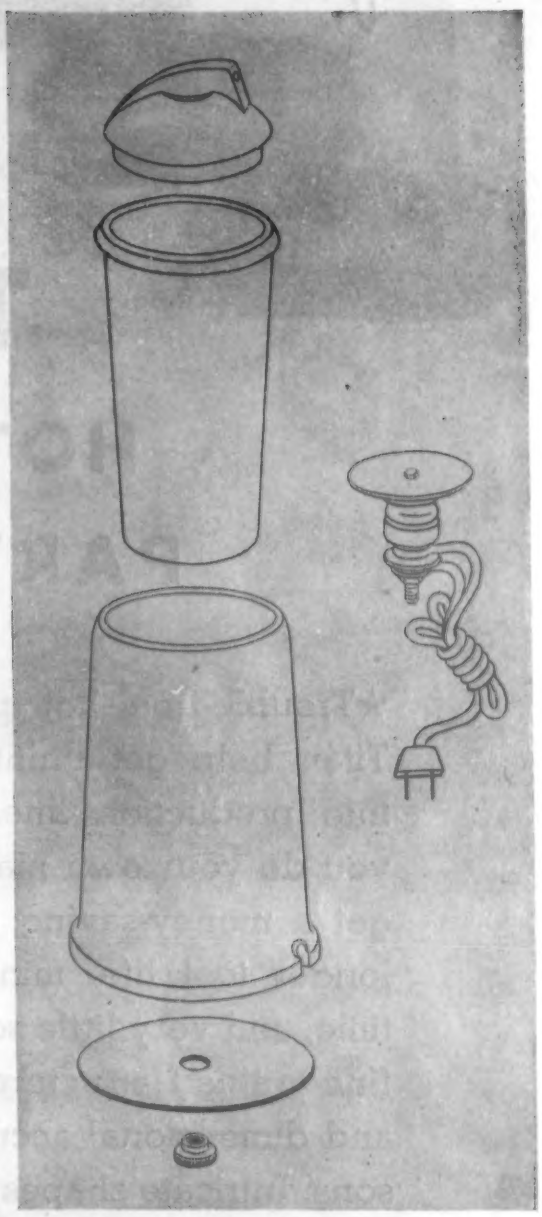


Service requirements are severe. The material must take exposure to steam for hours at a time without affecting physical or electrical properties. It must withstand various medicants while in operation, and alcohol solutions are often used for cleaning.

A careful analysis proved a Durez 75 type of material to be "just the ticket". This phenolic is a high chemical-resistant material, having very low moisture absorption, and good molding characteristics. Skillful designing and the right choice of material have been combined into a product whose lines and finish have plenty of eye-appeal.

One important sales advantage the designer has achieved over previous types is that the user no longer has an ugly, discolored vaporizer on his hands after a few applications.

The success of the DeVilbiss vaporizer is the result of manufacturer, molder and material producer working together. We suggest such teamwork may add something to the solution of your own design and engineering problem. We offer the facilities and research of our technical staff in determining the material best suited to your purpose. Durez Plastics & Chemicals, Inc., 95 Walck Rd., North Tonawanda, N. Y.



DUREZ
PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB

★Trouble-free hot pressed parts by Titan help get uninterrupted rhythm into production lines everywhere. If you do your own machining, you will get a money-saving surprise in much longer tool life, minimum machining time, and very little scrap. Their dense, fine-grained structure, sharp outlines, and dimensional accuracy are the reasons. Intricate shapes and thin sections are no problem with Titan. Send us your blueprints—you'll find us mighty interested in helping you increase your production, decrease your costs.

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Quality Alloys By Brass Specialists

Brass and Bronze Rod • Forgings • Die Castings • Welding Rods

quality has a strength value of approximately half of a good-quality gray cast iron.

The commercial silicon iron alloys contain carbon, and as in the case of gray iron, the carbon content has an important influence on the founding properties of the alloy.

The appearance of the graphite in silicon iron is apparently some indication of whether the alloy is hypo- or hyper-eutectic. Hyper-eutectic alloys have a "fine graphite" type of structure.

The quantity of fine graphite becomes larger as the eutectic carbon percentage is approached. Hyper-eutectic irons contain, in addition to fine graphite, quantities of primary or flake graphite.

It has been found that if a high casting temperature is used, there is a tendency toward the formation of big columnar crystals. On the other hand, a very low casting temperature produces a very fine grain indeed.

Experimental data show that at temperatures in excess of 1292 F. silicon iron disclosed a large degree of plasticity and toughness, as compared with its properties at normal temperature. At temperature in excess of 1472 F. excessive softening takes place, which allows easy distortion of the casting.

The toughness of silicon-iron at these temperatures allows of their comparatively safe handling during stripping from the molds. The adoption of an annealing treatment is a safeguard against the effects of internal stresses, and a treatment which brings about the elimination of the unstable carbide under conditions that leave no undesirable stresses is an additional advantage.

In the treatment used at the author's plant, the hot castings stripped from the molds are transferred to an annealing furnace, where they are maintained at a temperature of 1472 F. for a period of 4 hr., followed by a period of slow cooling to room temperature. It is important not to exceed 1472 F., or the metal becomes too plastic and may deform under its own weight.

—J. E. Hurst. *Foundry Trade J.* Vol. 71, Dec. 9, 1943, pp. 283-289.

Characteristics of Plastics

Condensed from "S.A.E. Journal"

Low density, ease of fabrication, low thermal conductivity, available transparency, and low unit cost for mass-production items are characteristics of organic plastic materials that make them attractive to the designer and the engineer.

Successful engineering design and application of plastics require the consideration of numerous factors that are not ordinarily considered with metals. The most important general considerations that are not covered by ordinary tables of properties of plastics are the effects of nature and mode or application of stress, amount of permanent dimensional change with time, required service temperature range, previous history of the material, and effect of temperature on physical properties.

Close Tolerances of Presteel Stamping Cut Costs

Pressed from 0.500" steel, heavy flanged sleeve bearings similar to the one shown above are held to tolerances of ±.001" both inside and outside of the barrel and have a finish specified in micro inches (before silver plating). Previously, such bearings have been machined from tubing at a cost nearly 50% greater than the price of Presteel stampings.

Worcester Pressed Steel stampings made by carefully controlled press operations producing uniform parts to tolerances of thousandths of an inch or less have helped many manufacturers to lower costs and improve their products. Our engineering and production experience is at your disposal. Mail samples or prints to—

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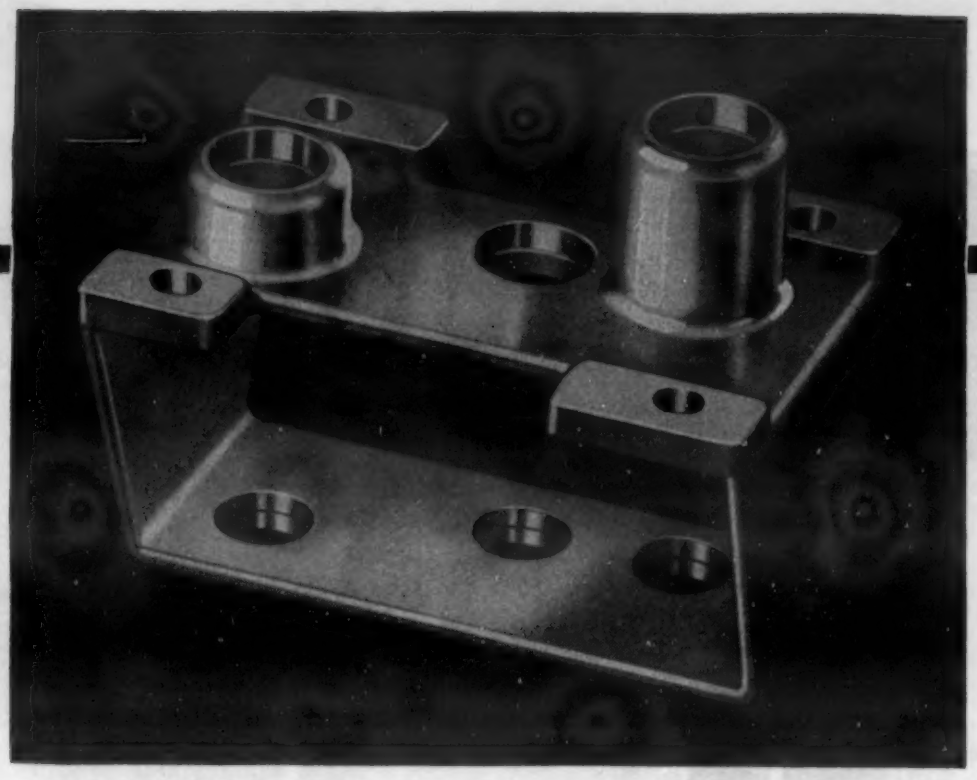
ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883



Attention . .

PRODUCT ENGINEERS

Before you start to design anything in metal that will eventually need machining, drilling and/or assembling, bring your idea to MONARCH where a corps of mechanical and metallurgical engineers will consult with you in an effort to produce the item, delivered in one piece, or a minimum of pieces, thus eliminating much of the above production costs.

Be assured you will obtain an unbiased opinion as to whether it should be produced by permanent mold, die cast or sand cast. We have all three methods available in our own plant. Also be assured that the zinc or aluminum alloy recommended will be the best one to use for that particular item and its uses; and that continuous chemical, metallurgical and X-Ray checks will hold the job to that texture and strength.

Weight ranges for Die Cast — From ½ ounce to 16 pounds in ZINC and to about 6 pounds in ALUMINUM.

MONARCH ALUMINUM MFG. COMPANY

General Offices and Plant • 9235 Detroit Avenue

CLEVELAND 2, OHIO

All plastic materials are subject to plastic flow under any applied stress. Amount of flow depends upon nature of material, total time of application of load, and temperature at which load is applied.

Contrary to the effect observed in metals that "fatigue" easily, stresses applied quickly and removed quickly usually have less permanent deleterious effect than much smaller stresses applied for long periods of time.

One of the most important things to know is the actual temperatures that must be sustained in any proposed application, as the temperature limitations of plastics must be fully recognized. As little as 5 to 10 degrees extra affects the suitability of a particular type for a specific use.

A dead-load, or cold-flow, or "creep" type of test is more suitable for the evaluation of plastics than the usual stress-strain relationship showing "tensile strength" and "elastic limit." The former test is carried out on compression test samples in a unit consisting of a weighted lever that applies the "dead load" to the specimen through two parallel plates.

The time for 10% plastic deformation versus "dead load" compression stress is of the utmost importance in the engineering application of plastics, and is preferable to the common compressive-strength type of data.

Impact strength is also of considerable consequence, but a simple impact test can not indicate true performance characteristics. Relatively minor surface scratches can cause an appreciable decrease in both the flexural strength and the impact strength of plastics if they are perpendicular to the direction of applied tensile strength.

Temperature has a very definite effect on the tensile, compressive, flexural and shear stresses, and on modulus of elasticity. Impact strength, however, remains virtually independent of temperature.

Moisture content of plastics as determined by the relative humidity of the surrounding atmosphere is also very important, as humidity changes cause dimensional and strength changes.

Service life of plastics may be affected by the residual internal stresses set up during forming. They find relief by changing the shape or dimensions of the part. Elevation of service temperature and increase of humidity increase the rate with which these changes take place.

—W. F. Bartoe & D. S. Frederick *S.A.E. Journal*, Vol. 52, Feb. 1944, Trans. pp. 54-61.

Leaded Manganese-Molybdenum Steel

Condensed from "Metallurgia"

A comprehensive study was made of the comparative mechanical properties, grain size, hardenability and machinability of two ingots of manganese-molybdenum steel, to one of which 0.19% of lead had been added.

The chemical analysis of the heat was as follows: 0.36 C, 1.43 Mn, 0.225 Si,

Resimene

quick facts for engineers on a new Monsanto Plastic

HERE are the basic facts on Resimene, a new addition to the broad and versatile family of Monsanto Plastics, which every materials engineer will want to have covered in his data files.

You will want to know about it now for its unique electrical properties.

It will be important to you postwar for its rare combination of high heat resistance, wide color range, low water absorption and excellent weathering qualities.

WHAT IS RESIMENE?

Resimene is the name applied to all Monsanto Plastics based on melamine-formaldehyde resins. These will include molding compounds in which the resin is combined with cellulose and mineral fillers . . . bonding resins for plywood, fabrics and paper . . . and many resins for special industrial uses.

BASIC PROPERTIES

All Resimene compounds are thermosetting or heat hardening, yet they will have a wide color range and are marked by low water absorption, good resistance to boiling water, good acid and excellent alkali resistance, excellent weathering qualities, excellent electrical properties, and a remarkably hard, permanent surface. They are odorless, tasteless and inert to organic solvents. Articles molded from Resimene have high tensile and compressive strength and good flexural strength.

WARTIME USES

Resimene compounds are outstanding for their electrical properties, particularly their high arc resistance, and this is their most significant wartime virtue. One compound, Resimene 803A, has been especially developed for use wherever an electrical insulation is needed to withstand the higher voltage differentials and severe operating conditions commonly met by World War II electrical equipment. A cellulose-filled compound, Resimene 803A combines the high arc resistance of melamine resins with excellent moldability and good mechanical properties formerly expected only in general purpose phenolic compounds. You will find it useful for Army and Navy electrical connectors, in many such standard electrical parts as circuit breakers, jack panels, etc.

POSTWAR USES

Resimene's unique combination of a color range from translucent white to opaque black with high heat resistance, low water absorption and excellent wear and weather resistance will make it an ideal material for many applications which no plastic could fill before with complete satisfaction. For example, colorful buttons of Resimene will return from repeated launderings unharmed. Resimene dishes will stand hot water and vigorous scouring. Lightweight Resimene fixtures for incandescent lamps will be unharmed by the heat encountered. Doorknobs and other building hardware of Resimene will add a note of color that repeated handling and exposure to weather will not dim.

☆ ☆ ☆

FOR MORE FACTS

Resimene compounds are now allocated by WPB and are available only for direct military applications. If, however, you are working on a war production problem with a molder which Resimene might help solve, samples and trial orders under Limitation Order M331 can be supplied. And war or postwar there is no priority on further information. Simply write: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile family of Monsanto Plastics includes: Lustron polystyrenes • Monsanto vinyl acetals • Nitron cellulose nitrates Fibestos cellulose acetates • Opalon cast phenolics • Resinox phenolic compounds and Resimene melamine compounds. Forms in which they are supplied include: Sheets • Rods • Tubes • Molding Compounds Castings • Industrial Resins • Coating Compounds • Vuepak Rigid, Transparent Packaging Materials.

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OFHC
REG. U.S. PAT. OFF.

OFHC *is a universal copper.*

- It is an essential part of electronic devices.
- In that capacity it is accompanying our armed forces everywhere.
- Its unique qualities however do not restrict its use to special applications.

OFHC *is a versatile copper.*

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61 Broadway, New York, N. Y.

BOSSERT *for Stampings!*

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HEAVY AND LIGHT METAL STAMPINGS
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DEEP DRAWING
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WELDING

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Our capacity for deep drawing is 54" diameter x 18" deep, or 39" x 72" x 12", in all metals, and up to 7/16" gauge. *OVER 200,000 SQUARE FEET OF FLOOR SPACE!*

THE BOSSERT COMPANY, INC.
UTICA, NEW YORK
Established 1896
NEW YORK CITY DETROIT

0.032 S, 0.045 P, 0.43 Mo, 0.16 Ni, 0.11% Cr.

The steel was melted in an acid open-hearth furnace, poured into 4500-lb. big-end-up ingots and rolled into 4½ x ⅝ in. flat bars and 1, ⅞ and ¾ in. rounds.

Lead exudation tests of the slabs showed the steel to be free from lead segregation. Standard Jominy tests showed the non-leaded steel to have a slightly higher hardenability.

Longitudinal and transverse specimens from the flat bars were normalized, oil or water quenched, and tempered. Room temperature tensile and impact tests of these specimens showed little difference in the yield and tensile strength or the elongation and reduction of area between the leaded and non-leaded steels.

This was true of the transverse and longitudinal specimens. Nor was there any difference in these properties between the oil-quenched and water-quenched specimens.

All specimens showed yield strengths of approximately 118,000 p.s.i. and tensile strengths of about 125,000 p.s.i. The longitudinal specimens showed elongations of about 25% and reductions of about 60% while the transverse specimens had elongations of about 17% and reductions of about 35%.

The Izod impact strength of the non-leaded steel was slightly higher in all cases. Tests made on quenched and tempered rounds showed approximately the same tensile strength, yield strength, elongation and reduction of area as the tests on the flat bars.

Izod impact tests of the heat-treated rounds showed the leaded steel to have about 12 ft.-lb. less impact strength than the non-leaded steel.

The modulus of elasticity of the two steels was approximately the same at tensile strengths of 125,000 p.s.i. but at strengths of 147,000 p.s.i. the modulus of the leaded steel was somewhat higher.

Tests at 300, 350, 400 and 450 C. (570, 660, 750 and 840 F.) on longitudinal and transverse oil-quenched and tempered specimens from the flat bars showed the leaded and non-leaded steels to possess approximately the same tensile strength.

The elongation and reduction of area of the leaded steel at elevated temperatures were considerably lower than those of the non-leaded steel. The Izod impact strength of the leaded steel was somewhat less than that of the non-leaded steel up to 550 C. (1020 F.).

Elevated temperature tensile and Izod impact tests of oil-quenched and tempered round bars showed similar results to those from the flat bars. Tests of the damping qualities of the heat-treated leaded and non-leaded steels showed little difference between them.

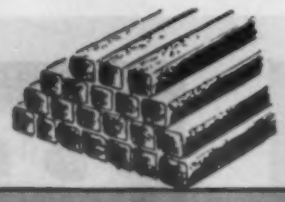
Fatigue tests showed very slightly higher fatigue ratios for the non-leaded steel. The leading produced an increase of about 38% in the machinability of the steel at both high and low tensile strengths, when tested by the standard Losenhausen machinability test.

The leaded and non-leaded steels had identical Barr-Bardgett creep-stress values at 500 C. (930 F.).

—T. Swinden. *Metallurgia*, Vol. 29, Nov. 1943, pp. 26-30.

THESE ARE THE BENEFITS YOU GET WHEN YOU BUY FORGINGS

1 FORGINGS CONSERVE METAL



Strength is a primary quality advantage of forgings. The metal bulk of many parts may be reduced because maximum tensile and torsional strength is obtainable in forgings through controlled grain flow and distribution of metal.

2 FORGINGS LESSEN SCRAP

In forgings it is possible to obtain uniformity of physical properties in the exact degree desired. Practically no rejections result. Heat treating forgings is a straight-forward production procedure, controllable at all times.

3 FORGINGS CONSERVE METAL BY WEIGHT REDUCTION OF PARTS

Reduction of dead weight is a common result of using forged parts because forging produces maximum strength in lighter sectional thicknesses, thereby permitting the use of lighter weight parts.

4 FORGINGS FACILITATE RAPID ASSEMBLY THROUGH WELDING ADAPTABILITY

Forgings provide a welding adaptability of widest range for fabricating complicated parts from two or more forgings.

5 FORGINGS REQUIRE LESS TIME TO MACHINE AND FINISH

Forgings are shaped in closed dies and require a minimum of machining or finishing because there is no bulk of excess metal to remove, and freedom from concealed defects avoids loss from rejections.

6 FORGINGS REDUCE ACCIDENTS TO MEN AND MACHINES

Freedom from concealed defects is an outstanding characteristic of forgings that underlies the greater margin of safety that forgings afford for men, machines and material.

7 FORGINGS CAN TAKE IT

By the forging process, stamina is achieved through concentration of grain structure and fibre formation at points of greatest shock and strain. Forgings provide high fatigue resistance which underlies dependable performance, and continuous operation over longer periods of use.

7 ADVANTAGES FORGINGS OFFER YOU

Are you obtaining the utmost benefits from your use of forgings? Many manufacturers, who have had long experience in the use of forgings, have found by rechecking parts against these advantages, that forgings offer further opportunities to conserve critical materials, or reduce weight, and frequently a faster method for machining and finishing.

Rechecking forged parts against these 7 advantages need not be a difficult or wasteful task. It may reveal unusual benefits which have been neglected or overlooked. Consult a forging engineer connected with your source of supply for assistance along this line.

SYMBOLIC EMBLEM OF THE DROP FORGING ASSOCIATION

Evidence substantiating benefits accruing from the 7 advantages which forgings offer is published in Drop Forging Topics, now in its 9th year.

ROP FORGING ASSOCIATION

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Drop Forging Topics contains technical information for design engineers, production executives, metallurgists and other technicians who are devoting all their effort to speeding up the production of fighting equipment. If you do not receive "Topics" regularly, send us your name. It's free.

Sand castings
These worm gears are typical products of the Ampco foundry. Precision heat treatment also available.

Centrifugal castings
Ampco pioneered in the centrifugal casting of aluminum bronze, offers long experience and special equipment.

Precision-machined parts
Large, modern machine shop ready to finish castings when desired.

Wrought products
Complete facilities, including extrusion mill for producing rods and bars.

Wear-resisting AMPCO METAL is available in all its forms from one completely equipped, dependable source

Let an Ampco Field Engineer give you the benefit of Ampco's 30 years of specialization in aluminum bronzes

Now standard for critical parts in nearly 100 makes of machine tools—in practically every American-built combat plane that flies—in ordnance, heavy machinery, and many another spot subject to wear, shock, fatigue, or corrosion—Ampco Metal is available in so many forms that it gives you great freedom of design for your post-war products. Investigate! Let an Ampco field engineer explain how you can provide parts that last several times as long as ordinary bronze—and give your customers that extra margin of safety that means genuine, lasting satisfaction. Write for bulletins.

A-3

Coated Welding Electrodes
Five grades of Ampco-Trode, for metallic-arc, carbon-arc, or gas welding of practically any combination of metals.

Non-sparking safety tools
Industry's standard, where explosive fumes, gases, or dust are present.

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Metal

The Metal without an Equal

Aluminum in the Canning Industry

Condensed from "Light Metals"

The canning industry constitutes an extremely important field of development for aluminum. For many years it has been served by the tinplate industry, and served well. However, tinplate is not without its faults and limitations. Tin supplies constitute the weak link in the chain.

Aluminum commends itself for consideration for canning mainly upon the basis of its physical, mechanical and chemical properties. Aluminum production is not only well established, but is well understood both metallurgically and commercially. No difficulties arise in producing metal of high purity to close dimensional tolerances in sheets, strips, coil, etc. to suit the users.

When aluminum corrodes, it produces white corrosion products that are not as unsightly as the corresponding rusty products on steel or tinned steel. Aluminum responds readily to the customary engineering fabrication processes of forming, drawing, etc., as well as to the less usual one of impact extrusion. Scrap value is high.

The criticism most frequently leveled at aluminum as a material of construction for rigid and semi-rigid containers is the difficulty — in this case one might say practical impossibility — of producing soldered joints in the metal.

Other alleged shortcomings are a lack of resiliency in the metal, which may result in permanent swelling and leakage after sterilization, and finally, the cost of the raw material. Considerable thought is being given to the problem of soft soldering aluminum, and it appears likely that a satisfactory solution may soon be attained.

Difficulties Overcome

The lack of resiliency shown by aluminum is another difficulty that is easily overcome by a slight departure from the normal methods of processing, and involves sterilizing in an autoclave under pressure instead of under atmospheric pressure.

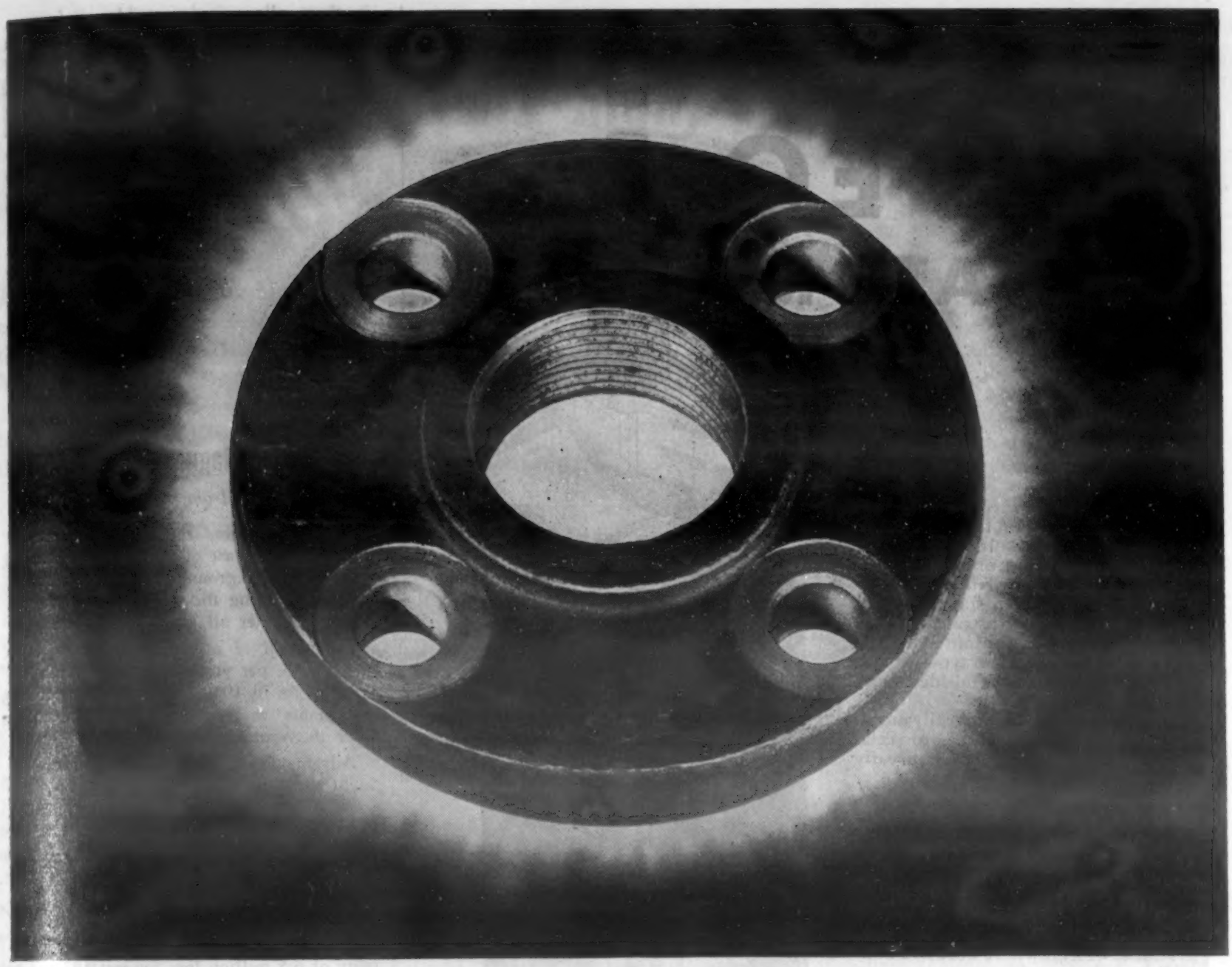
The cost factor needs to be examined in the light not only of initial cost of material but also of reduced tooling costs, the production of highly satisfactory containers with fewer rejects in packed goods, and the high scrap value of used cans.

When it is realized how little tin recovery has been practiced, and how simple aluminum recovery would be, the supremacy of tinplate for containers ceases to appear so firmly established.

Magnesium does not come into the picture, and is not considered likely to in the near future. In the present stage of development of magnesium and its alloys, a number of grave disadvantages compared with aluminum are to be observed, chiefly less suitable chemical, mechanical and physical characteristics (except low density, in which respect magnesium is superior to aluminum); the absence of the oxide film which, in the case of aluminum, is important both for corrosion resistance and also in decoration and protective treatment of the metal surface; and the higher cost of the metal while there has at the moment been insufficient study of the toxology of magnesium and the ultra light alloys.

What developments the future may see

(Continued on page 1244)



Knit A FLANGE? CERTAINLY!

If you could see inside this drop forged flange you would know what we mean. You'd see that the structure is of a fibrous nature and that these fibres are closely knit together into a tough, sinewy mass of strength and stamina. This structure is peculiar to drop forgings and is the result of a transformation that takes place when the heated metal is forced into the die under the powerful blows of the forging hammer.

That's the reason for the extra long life and high resistance to fatigue that characterize drop forgings. It's one of the reasons why Forgings by Phoenix are being used in many of the implements of war now serving on many battle fronts. And it's a mighty good reason for specifying Forgings by Phoenix when laying plans for your postwar products.

Speaking of postwar plans, now is the time to get them on paper . . . to get the designing and engineering done. And, if there's a drop forging application, our engineers will gladly work with you without any obligation on your part.

Forging Division of

PHOENIX MANUFACTURING COMPANY

CATASAUQUA PENNSYLVANIA

Forgings by **PHOENIX**

MOLDED *PLASTIC* HAVEG AGITATORS

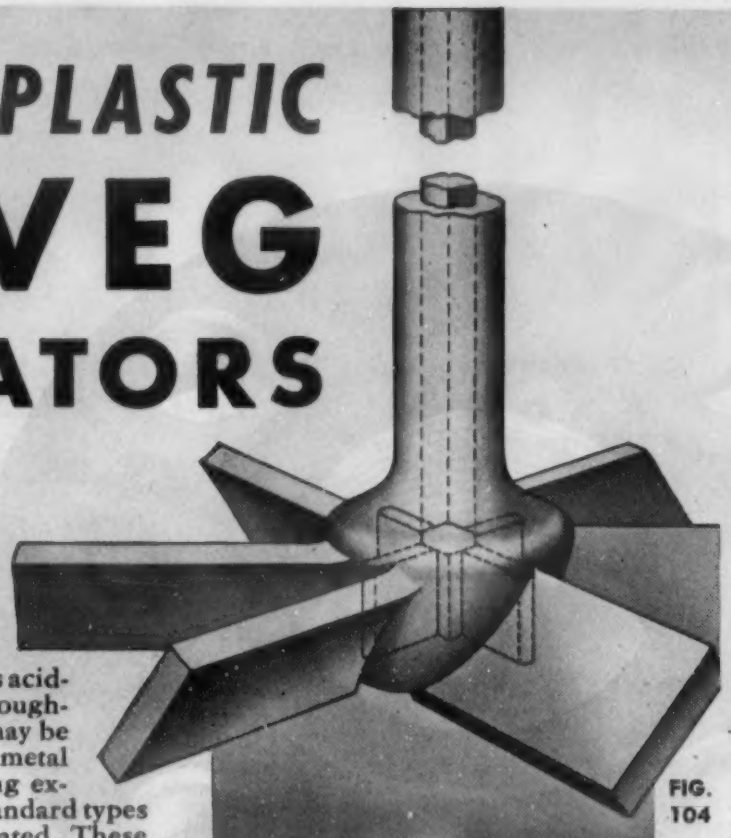


FIG. 104

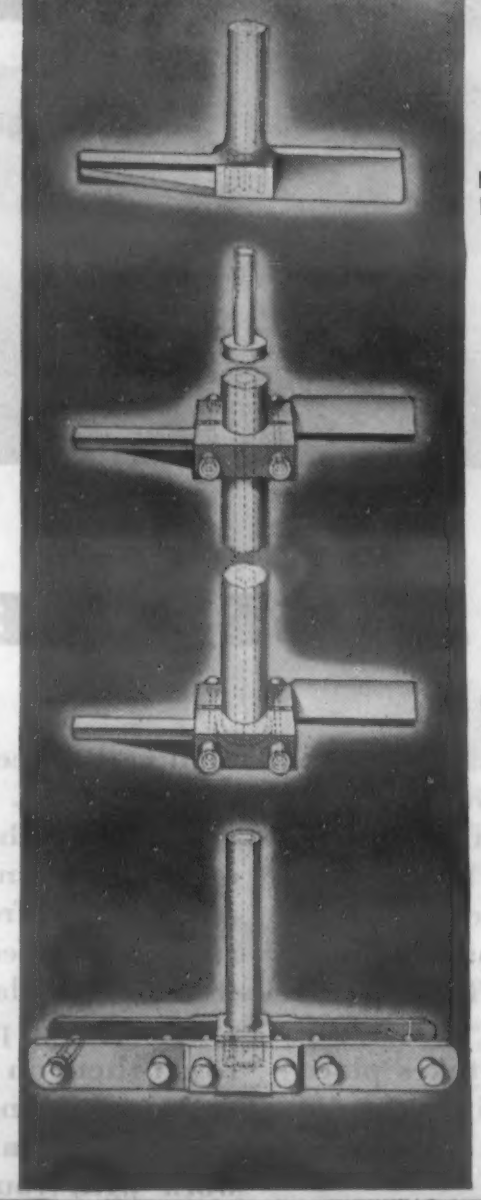


FIG. 103

FIG. 105

FIG. 106

HAVEG *itself* is acid- and alkali-resistant throughout its entire mass. It may be molded to shape on metal shafts without involving expensive molds. Four standard types of agitators are illustrated. These are typical of the almost infinite variety of designs and types of agitators which can be molded from HAVEG.

Figure 104: This integrally molded pitched blade agitator for relatively high shaft speeds is usually supplied in diameters up to 2′ 6″.

Figure 103: A plain, slow-speed, integrally molded, single-bladed agitator which is satisfactorily used for agitating free-flowing liquids and thin sludges. The blades can be supplied pitched or vertical.

Figure 105: HAVEG Agitator with demountable blades. A highly desirable design where abrasive conditions may make it necessary to replace blades. This type of blade may also be used to add blades to an agitator already in service.

Figure 106: A heavy-duty HAVEG Agitator. Has vertical double blades, thoroughly braced. They are also demountable. This type agitator has been made up to 6′ in diameter.

METAL SHAFTS—HAVEG COVERED

In all types of HAVEG Agitators the shaft itself is made of metal—and covered with HAVEG. This HAVEG covering is free to expand and contract. The positive method of attaching the HAVEG at the bottom is clearly shown in the illustrations. The blades themselves are always solid HAVEG.

HAVEG Bulletin F-3 gives complete engineering, design and application data on all types of HAVEG equipment. Tanks, Towers, Pipe Fittings, Fume Duct and many others. Send for a copy.

HAVEG-SARAN *Tubing; Pipe & Fittings; and sheets are available from stock.* **HAVEG-SARAN** *is also described in Bulletin F-3. Send for a copy now.*

HG-43

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NEWARK, DELAWARE
FACTORY–MARSHALLTON, DELAWARE

CLEVELAND, 550 Leader Building · CHICAGO, 1201 Palmolive Building · DETROIT, 2832 E. Grand Blvd. · LOS ANGELES, 601 W. Fifth St.

in these alloys is impossible to forecast. Tremendous strides are bound to occur, but at the moment there are no indications of any potential developments of interest in this field, except in the storage of slightly alkaline materials, *e.g.* alkaline hydrogen peroxide, for which aluminum is less suitable.

—*Light Metals*, Vol. 7, Mar. 1944, pp. 107-116.

Future of Magnesium Castings

Condensed from "The Foundry"

War exigencies, requiring the use of magnesium in vast quantities, have created a splendid background of practical experience in handling the material, and of performance under all kinds of service.

Production of magnesium is now 600,000,000 lb. per yr., as compared with 10,000,000 lb. in 1939. Some of the producing plants will probably cease operation after the war.

Advantages of magnesium include: (1) Light weight — magnesium, 0.065; aluminum, 0.1; gray iron, 0.26; steel, 0.285; brass, 0.307; copper, 0.322 lb. per cu. in.; (2) excellent machinability; (3) good damping characteristics; (4) high fatigue strength; (5) nonsparking; (6) nonmagnetic.

Its disadvantages are: Modulus of elasticity of 6.5 million lbs., against 10 million for aluminum and 28 million for steel; must be about 17% thicker in section to give stiffness against deflection; thermal expansion is greater than in aluminum, steel or gray iron.

Magnesium shows good corrosion resistance to ordinary atmospheric influences, unless submerged or kept wet in sea water, or exposed to tropical humid climates. By keeping nickel and iron to low limits, corrosion resistance is improved.

However, in tests involving alternate immersion in sea water, magnesium alloys showed six times the depth of corrosion of copper, considering weight ratios. The loss for tin bronze is only one-half that of commercial copper.

While subnormal temperatures do not markedly decrease physical properties of magnesium, it loses strength more rapidly than aluminum at temperatures above normal. It should not be exposed to temperatures above 300 F. for any great length of time.

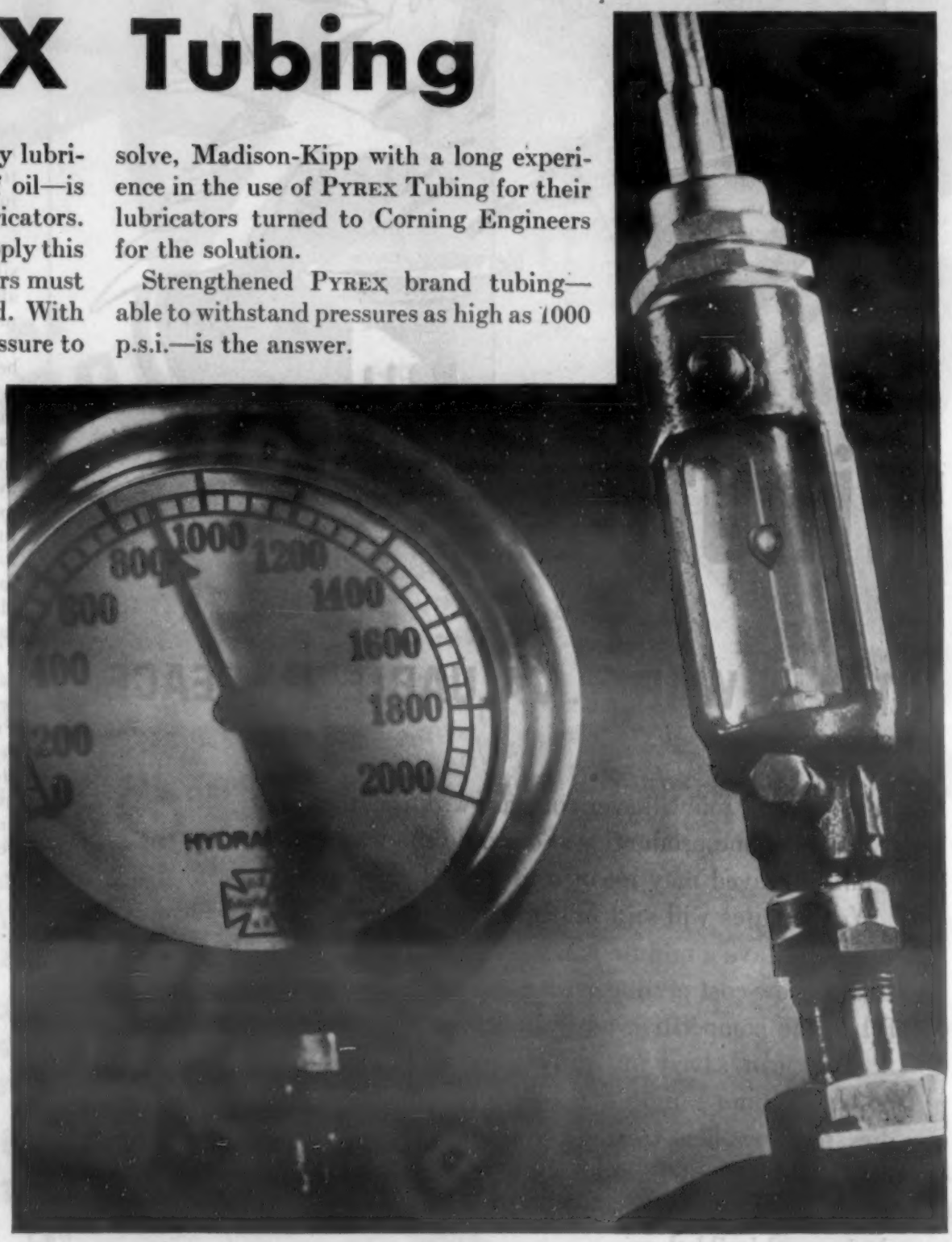
Magnesium is particularly susceptible to concentrated stresses as at notches, sharp corners, etc. Its creep value is somewhat lower than for aluminum, and shock resistance is somewhat less.

Two primary considerations for magnesium alloy castings are low thermal capacity, permitting rapid melting but also rapid cooling, and low specific gravity, which means that the metal does not differ greatly in weight from the non-metallic

When pressure runs high, use strengthened PYREX Tubing

To protect expensive machinery by lubricating with measured amounts of oil—is the job of Madison-Kipp's lubricators. Many of these lubricators must supply this oil against high pressures. Operators must be sure that oil is being delivered. With the problem of visibility under pressure to solve, Madison-Kipp with a long experience in the use of PYREX Tubing for their lubricators turned to Corning Engineers for the solution.

Strengthened PYREX brand tubing—able to withstand pressures as high as 1000 p.s.i.—is the answer.



PROPERTIES OF PYREX TUBING

HEAT RESISTANT:
Has approximately three times the thermal shock resistance of ordinary lime glass used for bottles and windows.

CORROSION RESISTANT:
Resistant to attack of all acids (except HF) and moderate alkalis.

DIMENSIONALLY STABLE:
Prolonged heating and prolonged exposure to solvents do not change dimensions.

IMPERVIOUS:
Not permeable to gases or liquids—even at elevated temperatures.

ABRASION RESISTANT:
Approximately twice that of ordinary plate glass.

MECHANICALLY STRONG:
Can be used at working stresses up to 1000 p.s.i. May be specially strengthened to permit working stresses as high as 4000 p.s.i.

TRANSPARENT:
Transmits visible, near infra-red and near ultra-violet light.

ELECTRICAL PROPERTIES:
High dielectric strength and low dielectric loss.

Available in diameters from ¼" to 4½" O.D. Three wall thicknesses—light, medium and heavy. Stock lengths—light wall—48"; medium and heavy wall—60".

Other lengths can be supplied on special order. Tubing can be furnished with regular cut, cut and ground, or cut and glazed end finish.

For more detailed information on properties, physical constants, sizes and uses, please use this coupon.

Industrial Division, Dept. MA2
Corning Glass Works, Corning, N. Y.

Please send me a copy of your Bulletin 843 on PYREX BRAND GLASS TUBING.

Name.....
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Firm.....
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"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING
Glass Works
Corning, New York

Pyrex Industrial Glass
BRAND

minutes...

VITAL IN WAR... VALUABLE IN PEACE

NO postwar job will ever compare with the urgency of wartime production. For while the war is on, a minute saved may mean a life saved, too.

Yet minutes will still be valuable when peace returns. To save a minute is always to cut a cost. And it is the low-cost producer who will be most successful in the competitive postwar field.

Acme can save you minutes—wartime minutes and peacetime minutes as well. If you need new dies, patterns, heat-treated aluminum castings, Acme can supply them. Should your present or postwar production require special tools, Acme can both design and build them.

Acme consulting engineers have helped many a wartime producer to conquer production line problems. These same engineers will be equally helpful during the critical transition from war to peace.

Preliminary recommendations submitted without obligation.

ACME *Pattern and Tool Company, Inc.*
DAYTON, OHIO

FOR VICTORY
BUY
WAR BONDS
AND STAMPS

HEAT-TREATED ALUMINUM CASTINGS . . . PATTERNS . . . TOOLS . . .
TOOL DESIGNING . . . PRODUCTION PROCESSING

inclusions, and that the pressure of the pouring head is low.

As some type of inhibitor must be present in green or dry sands, synthetic sands are generally used, increasing cost somewhat. Superheating offers definite and positive means of controlling grain size, which do not differ greatly in light and heavy sections.

Microporosity is hard to avoid in magnesium alloys. Compositions high in aluminum are less subject to it. It can be controlled to some extent by gating and chilling.

Magnesium alloy castings do not air age into the final condition with higher tensile and lower elongation as rapidly as aluminum. Aluminum takes about three months, whereas magnesium alloys take years, so that the latter may frequently be used in the solution-treated condition.

An average figure for the weight of good magnesium castings would be 1 lb. for each 5 lb. poured, as compared to 1 lb. for each 2¾ lb. poured for aluminum. The average cost is about $2.55 per lb. for magnesium as against about $1.75 for aluminum, which means, considering weight ratios, that the cost of magnesium alloy sand castings is not far from that for aluminum. Magnesium may require more care in machining.

The use of permanent mold magnesium castings, favorable where production will repay the cost of the molds, is increasing. Pressure die castings do not lend themselves to heat treatment, but offer the shortest and most direct route from raw material to finished product. Magnesium and aluminum are not well adapted to centrifugal casting.

—D. Basch. *Foundry*, Vol. 72, Jan. 1944, pp. 116, 199-202.

Endurance of Steel Members

Condensed from "Product Engineering"

A method is given of evaluating the safety of flexurally stressed heat treated steel members against the type of failure that originates below the surface from repeated stresses in excess of the endurance limit.

If a homogeneous member is subjected to steady repetitive or alternating bending stresses, failure will start at the surface, but if it is non-homogeneous, failure may start at some point below the surface.

A good example of a non-homogeneous member may be offered by some of the NE steels when heat treated in large sizes. A hardness traverse of the cross section of such a member may be made, or it may be calculated from the Jominy curve; for example, a 3-in. round of a 0.3% C NE steel, quenched and tempered, showed Rockwell C 45 at the surface, 22 at ½ in. from the surface, and 19 at the center. These hardnesses may be converted to approximate tensile strength values by means

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of standard conversion tables to obtain the tensile strength of the fibers of the cross section.

In the example above, the corresponding tensile strengths would be approximately 212,000 p.s.i. at the surface, 115,000 p.s.i. ½ in. from the surface, and 100,000 p.s.i. at the center.

It has been well established that the endurance limit is equal to about half the tensile strength, barring notch effects and dimensional stress raisers. Therefore, the tensile strength traverse can be replotted as approximate endurance limits, which would give 106,000 p.s.i. for the surface and 57,000 p.s.i. for ½ in. in the above example. The final replotting represents unit endurance limit divided by stress.

In the example, there was a fair margin of safety at the surface (1.42) and an ample factor at the center, but at ¼-in. below the surface, the endurance limit was equal to the stress. Therefore failure would be expected to begin below the surface, after about 1,000,000 reversals of stress.

If the unit stress at the point of minimum margin of safety is greater than the endurance limit, then the expected life can be obtained approximately from SN curves, which are available for most steels.

—F. Franz. *Product Engrg.*, Vol. 15, Feb. 1944, pp. 97-98.

Stress Corrosion Properties

Condensed from "Zeitschrift für Metallkunde"

The tendency towards stress corrosion in relation to precipitation hardening temperature and time was determined for two groups of wrought aluminum alloys: Aluminum alloys containing 4.5 Zn, 3.5 Mg, 0.08 to 0.14 V and 0 to 0.8% Cu and hardening by a ternary precipitant T of unknown composition; and (2) alloys with 6 to 8 $MgZn_2$, 0 to 0.29 V and 0 to 0.4% Cu.

Previous research work had indicated the beneficial effect of small additions of vanadium and copper when low temperature precipitation hardening was applied.

Stress corrosion increases with hardening time for group (1), but decreases in group (2). These differences in behavior are disclosed by micro-structural examination to be attributable to differences in the manner of decomposition of the solid solutions.

No benefit accrues from the addition of vanadium and copper in group (1) if the precipitation hardening is carried out above 212 F., while up to 176 F. a notable improvement of stress corrosion stability is obtained.

As to group (2), vanadium and copper additions result in a greater resistance to stress corrosion after precipitation hardening at both atmospheric and raised temperatures.

—W. Bungardt & G. Schaitberger. *Z. für Metallkunde*, Vol. 35, Feb. 1943, pp. 47-55.

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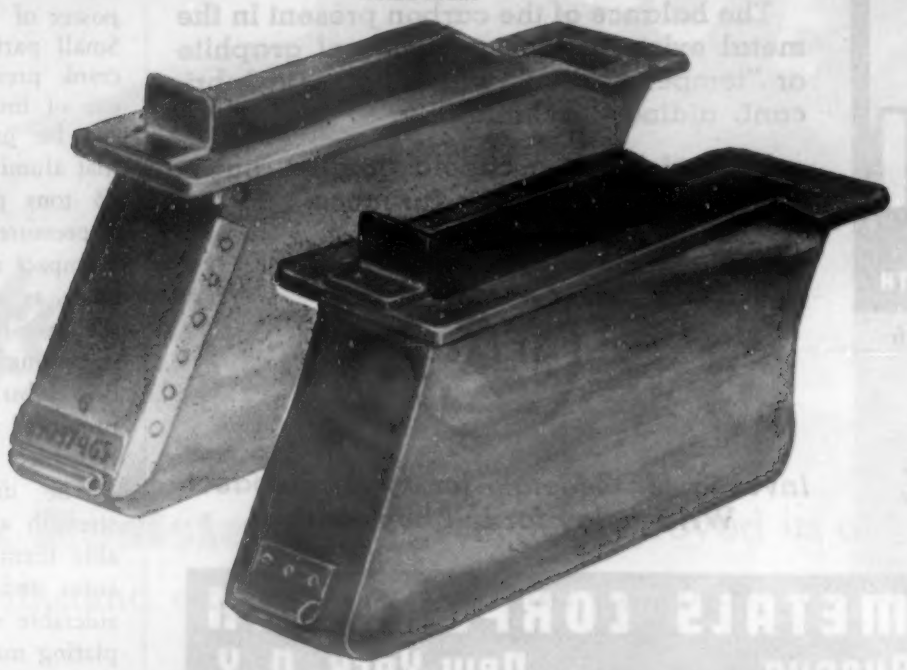

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Impact Extrusions

Condensed from "S. A. E. Journal"

With the impact-extrusion method, a single press stroke changes a slug of metal into the completed article. The high pressure developed causes the cold metal to flow to the desired shape. Many airplane parts, normally produced by casting, forging, or machining from solid stock can be produced very rapidly and economically by this method.

Aluminum and its alloys can be extruded. Their size is limited only by the power of the press available for the work. Small parts can be produced on standard crank presses, and in large quantities by use of multiple dies. Any type of press can be used. Experiments have shown that aluminum requires a pressure of about 45 tons per sq. in., while 24S requires a pressure of about 90 tons per sq. in.

Impact extrusion can be used advantageously as a very satisfactory substitute for the drop-hammer process. Because of the increasing difficulty in obtaining forgings, this substitute method should be rapidly promoted and used to the maximum extent possible.

The dies used must have sufficient strength and proper heat treatment to enable them to withstand the extreme pressures and impact shocks imposed. Considerable wear may take place. Chromium plating materially lengthens the life of the dies.

Advantages of this form of production include (1) considerable increase in the density of the metal; (2) relatively low cost of tools; (3) very low production cost, skilled labor being unnecessary; (4) automatic attainment of extremely close tolerances; (5) no set limitations in regard to form or shape of the parts that can be produced, with no limit to the height to which a slug can be driven.

(6) Great broadening, by means of secondary operations, of the field to be covered by this system of production; (7) uses of thermal methods to supplement the improvement by strain hardening brought about by this method; and (8) production of complicated designs and shapes that would be very difficult or impossible to produce by any other method.

—Phil Koenig. *S.A.E. Journal*, Vol. 51, Nov. 1943, Trans. pp. 415-419.

Welded Railroad Rails

Condensed from "Railway Age"

Questions as to what happens when rails are welded into long strings and laid as track, difficulty of maintenance, trouble from expansion, probable life, and so on have been in the minds of maintenance officers, but have remained largely unanswered.

Long stretches of welded rail have been in service in this country in tunnels as early as 1930, and in the open since 1932, but the officers who laid the rails have preferred not to commit themselves until they are more certain of its performance.

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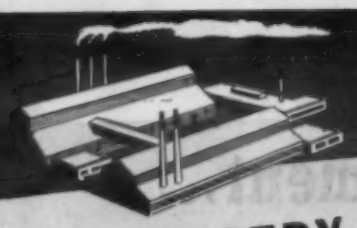

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It is believed that five yr. is the minimum period of service upon which sound conclusions can be based. All reports indicate that track maintenance in tunnels has been greatly improved and simplified by welding into long lengths. More interest has been shown in performance under temperature changes than in any other detail.

If unrestrained, the normal expansion of rail under a 100-degree rise in temperature is about 41 in. to the mile, and under some reported conditions might exceed 60 in. However, all roads reported they were experiencing no difficulty from end or intermediate movement of the rail.

Investigations has shown that restraint to movement arises from the friction between the rail and the tie-plate or the tie, and that this can be augmented by such rail fastenings as the spring clip type, and by applying anti-creepers, while the rail ends themselves apply considerable restraint.

The ultimate restraint must come from the resistance of the ballast to movement of the ties. The restraint has been determined to produce an internal stress of 195 p.s.i. per degree, so that for a 100-deg. change the stress would be 19,500 p.s.i.

Actual Stresses Lower

However, this stress occurs only above or below the temperature at which the rail was laid, so that when rails are laid at 50 to 60 F., the maximum stress is sharply reduced. Actual measurements of stresses at the rail joint have shown that it may be as much as 5,000 p.s.i., or about 65,000 lb. at each end of the rail.

Tie restraint may be as low as 20 lb. per tie per rail in each direction, for double-shoulder tie plates, or as high as 700 lb. for spring clip type fasteners. Anti-creepers exert a restraint of 850 lb. per tie per rail.

Long welded rails seem to present no maintenance problem. Only one case of buckling was reported, and this was in a rail laid at a temperature well below 60 F. It is the general temtimony that the welded rail rides more smoothly than that with conventional joints, and can be kept in smooth-riding condition with less effort. One road estimated that cost of maintenance had been reduced 25%.

While limited experience has prevented engineers from making definite conclusions, they do not believe there is any physical limit to the length of rail that can be installed, and that this length will be determined solely by the necessity for inserting joints for signals and turnouts.

Difficulties of adverse conditions encountered were (1) the initial expense; (2) difficulty of replacement in case one or more rails require renewal; and (3) difficulty in mobilizing equipment for handling long strings of rail.

[*Welding of railroad rails may be done in position by the thermit process, or elsewhere, by the thermit, Sperry or Oxweld processes. Welding "in track" has not been used as widely as the other type, which uses more elaborate equipment and is done ordinarily on a nearby siding. The thermit process is well known, involving the virtual "casting" of the metal resulting from the reaction of aluminum and iron*

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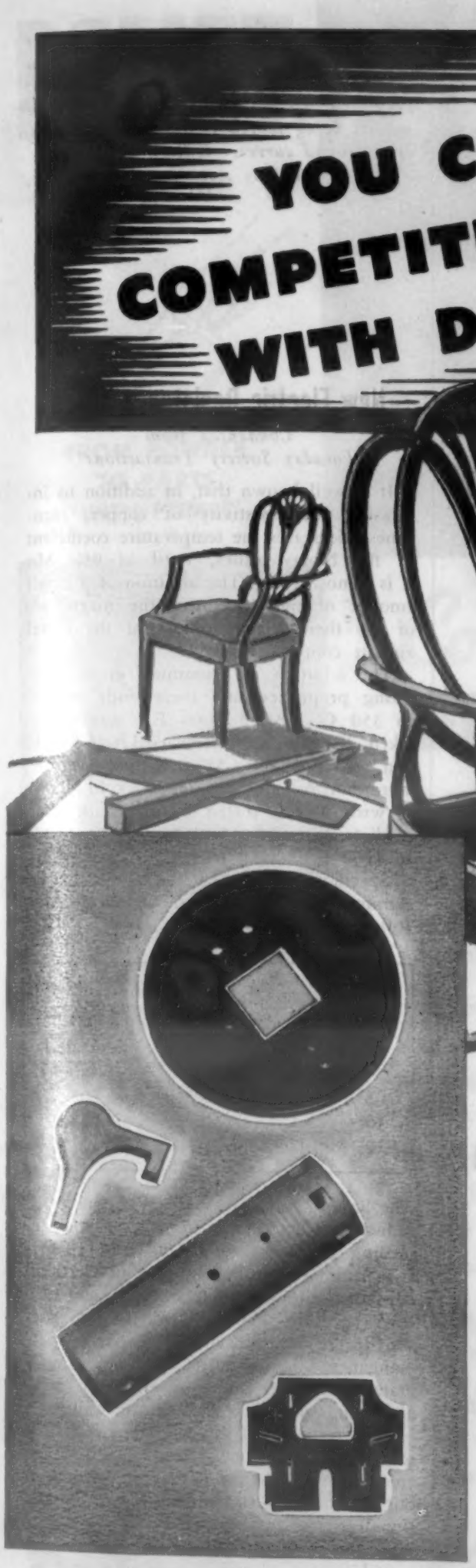

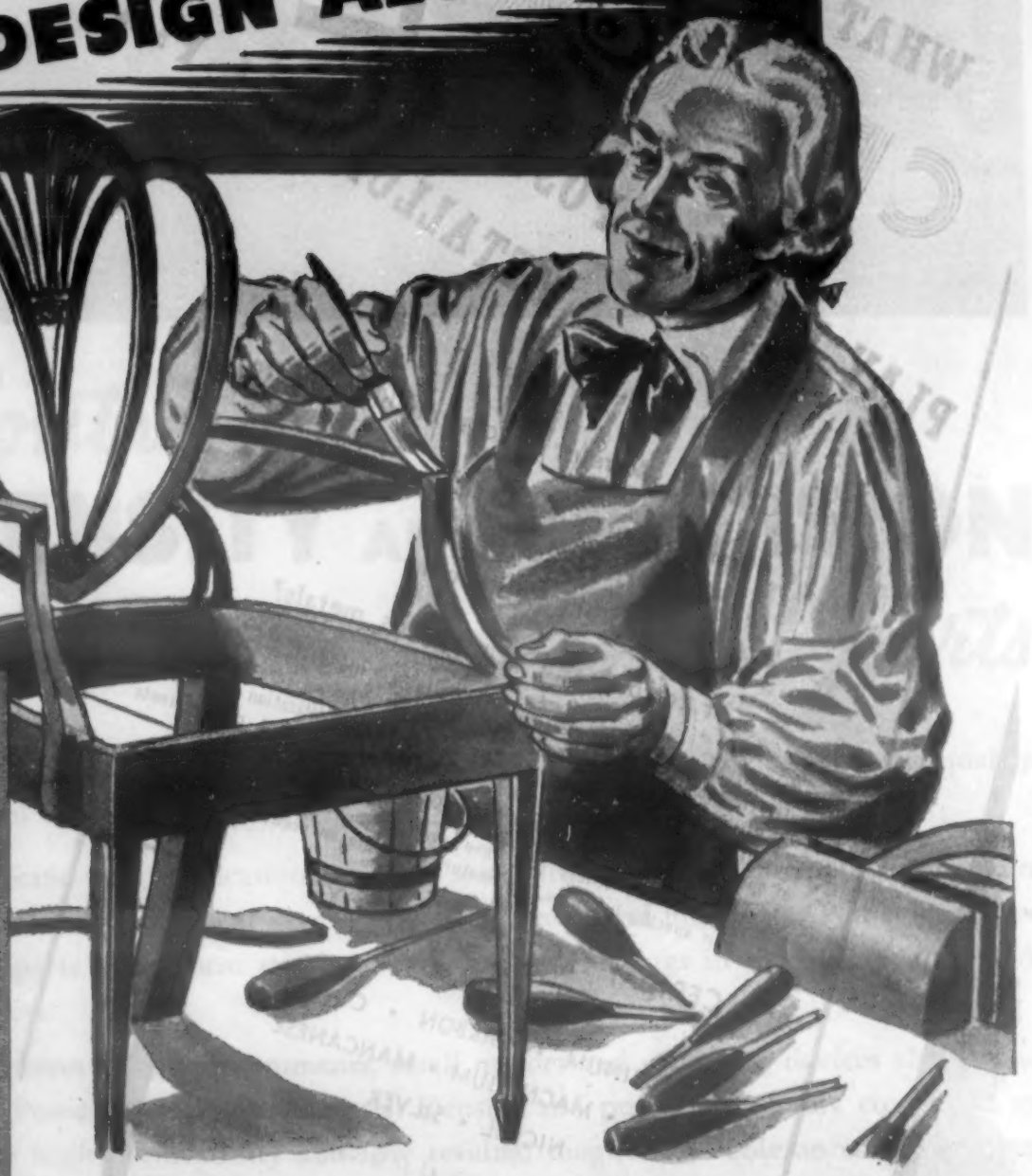

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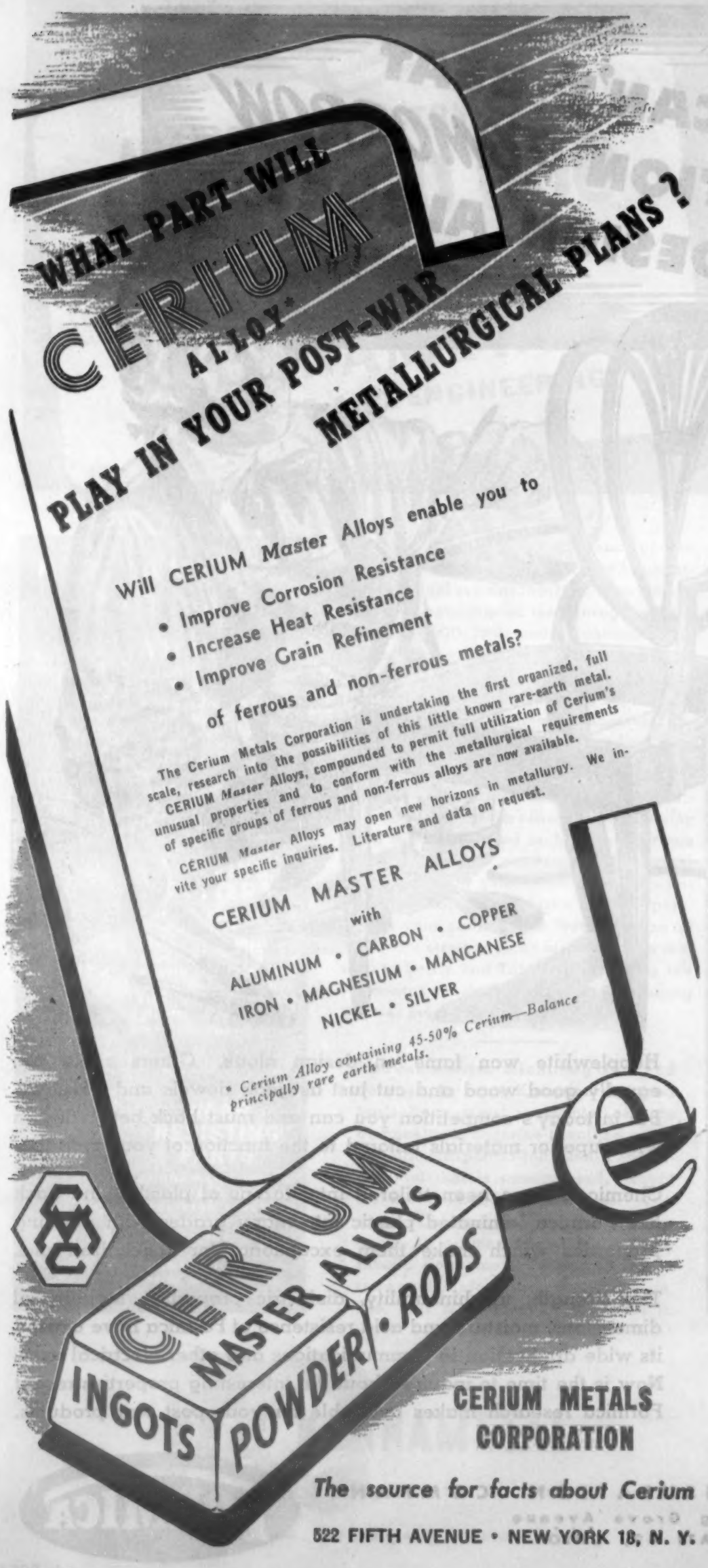
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oxide. The Sperry process is a flash butt method and the Oxweld method is a pressure weld. The rail when welded into long lengths has sufficient flexibility to permit its being moved into position on cars, even around curves.—K.R.]

—*Railway Age*, Vol. 116, Feb. 12, 1944, pp. 340-343, 346.

New Electric Resistance Alloys

Condensed from "Faraday Society Transactions"

It is well known that, in addition to increasing the resistivity of copper, manganese decreases the temperature coefficient of the binary alloys, until at 9% Mn it is almost zero. The addition of a small amount of nickel reduces the magnitude of the thermoelectric effect of the metal against copper.

The addition of aluminum gives interesting properties, and their study at 200 to 350 C. (390 to 660 F.) was undertaken. The alloys studied varied from 5 to 10 Mn, from 1 to 4.5% Al, balance Cu; were hot rolled from ingots, cold drawn to wire, or cold rolled to strip, with intermediate anneals at 600 to 650 C. (1110 to 1200 F.).

Specific resistance of the alloys, as determined on 0.064-in. diam. wires, were as follows:

Alloy metal, %		Specific resistance Microhms/sq. cm./cm.	
Mn	Al	Hard	Annealed
5	1	21.7	21.35
5	2	23.0	22.60
10	1	37.25	36.55
10	2	39.05	38.25

The hard-drawn wires had undergone 50% reduction in cross section, while the annealing had been done at 600 C. (1110 F.).

It is important that scaling in electrical resistance alloys should be small, and also that the scale should be adherent to prevent progressive action. While the copper-manganese alloys scale readily, even at moderately elevated temperatures, those with aluminum are more resistant to scaling.

The ternary alloys containing 2% or more Al generally showed a slight increase in weight after two hours oxidation, but the increase did not continue proportionally. Those with only 1% Al oxidized progressively with eventual flaking.

Stability of electrical resistance at temperatures above normal is important in resistance alloys. Tests showed that while the manganese or aluminum binary alloys underwent changes in resistivity of more than 1% when heated at 350 C. (660 F.) for one month, the ternary alloys showed changes of less than 1%.

Tests for stability under intermittent heating over a two-weeks period showed that the 10 Mn, 2% Al alloy was satisfactory under such conditions. The tempera-

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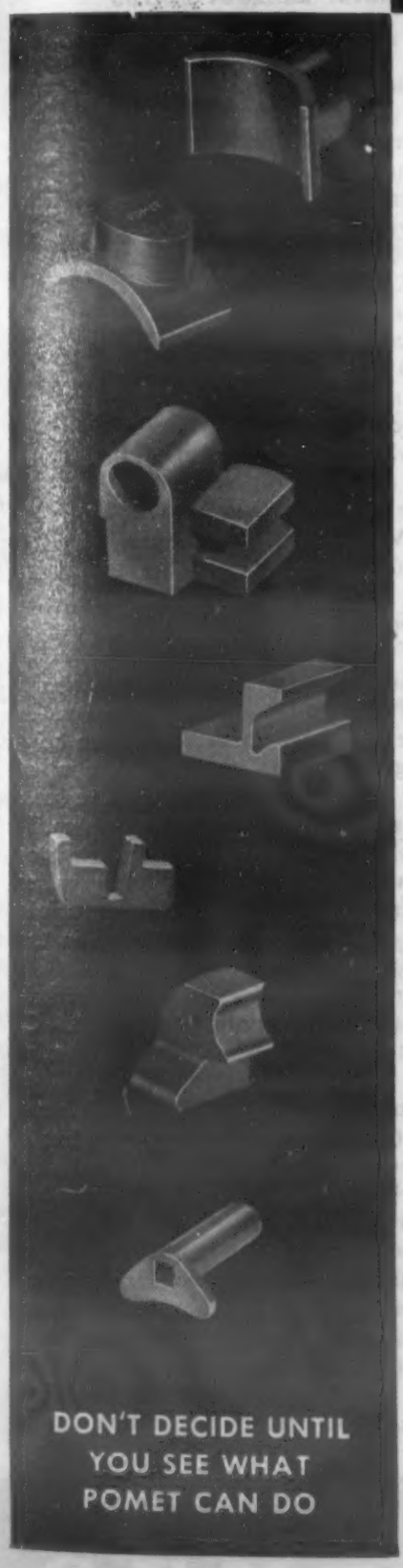

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ture coefficient of this alloy was determined over the range from 20 to 350 C. (68 to 660 F.), and found to decrease to 200 C. (390 F.), then to increase to 350 C. The coefficient is about —0.000045 for the lower range and +0.00005 for the higher, giving a net change that is negligible.

Linear expansion in resistance alloys is required to be sufficiently low, so that loosely wound spirals supported on formers will not buckle unduly. Tests made upon the same alloy showed the coefficient of expansion to be a practically linear function of temperature, and about 0.0000175 C. This value is about normal for resistance materials.

—Maurice Cook & W. O. Alexander. *Trans. Faraday* Soc., Vol. 39, Sept-Oct. 1943, pp. 260-265.

Motor Exhaust Valves

Condensed from "Metal Treatment"

For automobile engine work, the most widely used exhaust valve material is Silchrome, an air-hardening ferritic steel containing 0.4 to 0.5 C, 3.25 to 3.75 Si, 0.5 max. Ni, 7.5 to 8.5% Cr. This is heat-treated by oil-quenching from 1050 C. (1920 F.) and tempering at 870 C. (1600 F.) to produce a structure of small spheroidal carbides in a background of lightly tempered martensite. The hardness is 255 to 286 Brinell.

This material, however, is rapidly attacked by the decomposition products from tetra-ethyl-lead fuels, and it is thus usual to apply a coating of Stellite to the valve faces by welding with an oxy-acetylene flame. Very thin electro-deposits of chromium (0.005 in. thick) have also been used for the valves of motorcycle engines, but extended experience of their use is lacking.

The most common failure of the exhaust valves of automobile engines are cracks in the valve seats, due to defects in the original forgings, or to the propagation of cracks in the oxide scale on the valve seat; burnt valves, often resulting primarily from gas leaks due to faulty alignment or distortion during assembly; broken valves due to fatigue cracks having their origin in small corrosion pits; and defects in the Stellite facings.

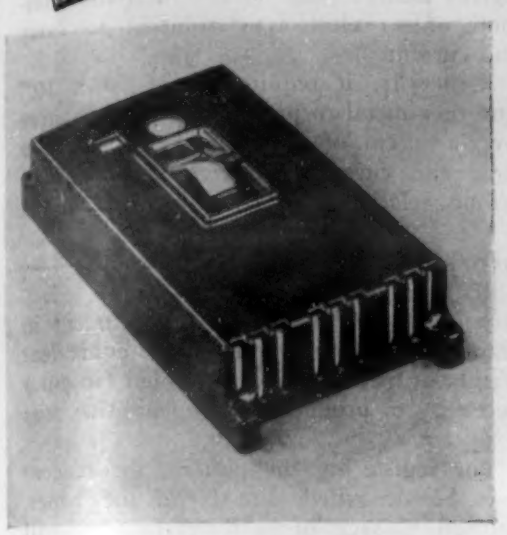
For aero engine valves, austenitic nickel-chromium steel containing 0.35 to 0.5 C, 1.0 to 2.5 Si, 1.5 max. Mn, 10.0 min. Ni, 12.0 to 16.0 Cr, 2.0 to 4.0% W is almost exclusively used. This is much more resistant to corrosion than Silchrome, but it is usual to coat the entire head and seat with Stellite or an 80:20 Ni-Cr alloy (Brightray).

The stems should be honed to a good surface finish, and it is necessary to provide a hardened tip to the valve stems to prevent splaying at the points where they are in contact with the valve rockers. The tips may be formed by welding on a disc of hard 1.0% C steel, by pressfitting a case hardened cap, or by applying by welding a built-up tip of No. 1 Stellite.

—C. A. E. Wilkins & W. J. Currie. *Metal Treatment*, Vol. 10, Autumn 1943, pp. 147-152, 201.

Designing Molded Plastics Parts: HOLES

From the engineering files of One Plastics Avenue



COMPRESSION MOLDED PART:
Holes in top made by butt pins, holes in end made by vertical grooving.

The location of holes and the decision as to whether or not they should be included in a plastic part is based chiefly on economy of manufacture. Location and design of holes in plastic parts does not necessarily follow rules which apply to other materials because of the physical properties of plastic materials.

The length, diameter, shape, and number of holes incorporated in a molded plastic part depend upon three factors:

(1) Type of molding employed
(2) Type of compound used
(3) Mold design

Standard *compression* molds require pins and other mold members of sufficient size and strength to withstand pressure of plastic material as mold closes.

Injection and *transfer* molds may employ smaller and more delicate pins and mold members as compound is introduced into mold cavity in a semi-fluid state.

High impact plastic materials (coarse fillers) require stronger mold pins than materials with finer fillers.

Proper mold design takes into account and makes full use of all the physical characteristics of the steels from which molds are built.

WAYS TO MOLD HOLES

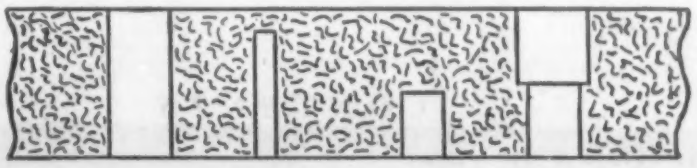
ENTERING PINS—(See A) Holes are formed by pins projecting through the mold cavity into a supporting opposite member. Holes made by entering pins maintain good alignment and are easily finished.

BUTTING PINS—(See D) Holes are formed by pins projecting into the mold cavity from opposite sides which meet when the mold closes. Holes made by butting pins decrease molding costs, may cost more to finish. It is desirable that one pin be approximately .020″ larger in diameter than the other.

BLIND HOLES—(See C) Holes are formed by pins projecting into the mold cavity. Blind holes are sometimes used as drill spots.

DRILLED HOLES Drilled holes are recommended when ratio of length to diameter exceeds limits shown at right, or when it is economical to avoid split mold construction. It is sometimes desirable to drill holes when tolerance of location is closer than normal molding uniformity permits. Holes may be formed in vertical walls by molding grooves in direction of mold travel and by removing remaining flash. (See photo above.)

Distance between a hole and an insert should not be less than $\frac{1}{32}$″; distance between any two holes should not be less than $\frac{1}{16}$″; distance from hole to edge of part should not be less than $\frac{3}{32}$″.



A B C D

A. Through hole formed by pin attached to one mold member which extends through cavity and enters opposite mold member.
B. Poorly designed blind hole (excessive length for its diameter).
C. Well designed blind hole formed by pin projecting into cavity from one mold member.
D. Through hole formed by pins which meet as mold is closed.

RATIO—PIN LENGTH TO DIAMETER

(Blind Holes—Compression Molded)

Hole Diameter (D)	Depth of Hole (Pin Length)
Up to $\frac{1}{16}$″	1 D
$\frac{1}{16}$″ to $\frac{3}{16}$″	1½ D
$\frac{3}{16}$″ to $\frac{3}{8}$″	2 D

Length to diameter ratios increase as diameters increase.

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Electrographic Analysis

Condensed from "Metallurgia"

Electrography developed from the contact print method. It consists of the electrolytic transference of ions from the surface of a sample on to an absorbent medium, such as paper. The ions are detected by the colors that they give, with reagents applied to the absorbent medium either before or after electrolysis.

Essentially, the apparatus consists, in order, of a base plate of aluminum or of some non-conducting material with a thin sheet of aluminum fixed to its upper surface; a sheet of absorbent paper, moistened with a suitable electrolyte, such as potassium chloride or potassium sulphate solution; another sheet of absorbent paper carrying the reagent; the specimen, with the face to be tested resting on the reagent sheet; and a metal plate pressing the whole together.

The metal plates have terminals attached, the lower ones being the cathode, and the upper, the anode. Various modifications of this basic apparatus have been suggested.

A dry-cell battery capable of delivering 22.5 volts is recommended. It should be connected in series with a variable 500-ohm resistance and a milliammeter.

Absorbent paper is usual for the simpler type of work, where very fine structure need not be recorded. A fairly hard paper that will not shrink much on drying should be used. Photographic paper, plates and film have a very wide use.

If the silver in the emulsion serves no useful purpose in the test, it must first be removed by hypo. At the same time, it is advisable to harden the gelatin by a chrome alum bath. Non-waterproof cellophane has advantages in certain cases.

Another medium is a thin sheet of plaster of Paris, which is prepared in a specially designed mold so as to have smooth surfaces and a thickness of about 1 mm. These sheets may contain any insoluble reagents desired, and do not need the addition of an electrolytic solution to carry the current.

Generally, it requires about 50×10^{-6} gm. of a metal to produce a strong positive over a sq. cm. of surface. The approximate time and current necessary to produce a strong electrograph can be determined from the equation $TI = 96{,}500 \frac{aK}{E}$, where T = time in sec., I = current in amp., a = area of surface, E = equivalent weight of metal, and K = amount (in gm.) necessary to produce a strong positive over 1 sq. cm.

For registering the pattern, the reagent may be deposited directly in the paper, and on passage of current, the ions will alter the reagent. Alternatively, the ions may first be trapped in an inert medium, and subsequently developed by appropriate reagents. Each of these has its appropriate spheres. Often, preliminary tests will be required to determine which procedure will give the best results in any specific case.

Electrography has been used for examining coatings of one metal on another; investigation of minerals containing copper, nickel and cobalt by a single test; determination of distribution of lead; detecting gold in bulk metal and in plating; and detection of molybdenum in alloy steels.

—David L. Masters. *Metallurgia*, Vol. 29, Dec. 1943, pp. 101-104.

Control of Fine Finishes

Condensed from "Aircraft Engineering"

By means of a microscope with magnification up to 200 diam., it is possible accurately to measure and control certain types of finish. This method is applicable only to a finely finished convex or flat reflecting surface, and not if the average height of surface above mean line exceeds 20 micro-in.

The set-up is such that one views the surface at a magnification of 200 diam. and at the same time makes use of interference fringes to give a contour-lined image, the vertical interval being about 12 micro-in.

The type of microscope depends upon parts to be examined. If available, a Vickers projection microscope is recommended. Besides a microscope, a cover glass, 15-mm. round or square and 0.15-mm. thick, and a sodium or mercury lamp, or other source of light, is necessary.

For line inspection, never use anything more powerful than a 2/2 in. objective in conjunction with an eye piece to give

(Continued on page 1262)

*Operator views image **directly** as parts are carried along on conveyor system. Convenient shutter controls confine radiation to part being examined; extraneous light is reduced to a minimum thus increasing the image sharpness.*

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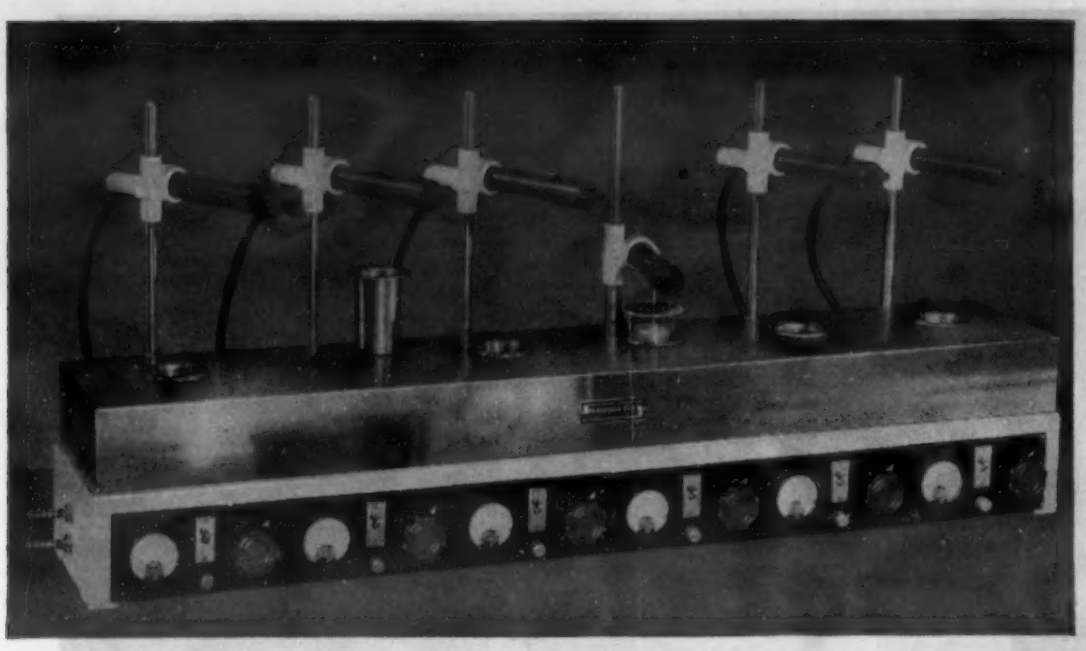

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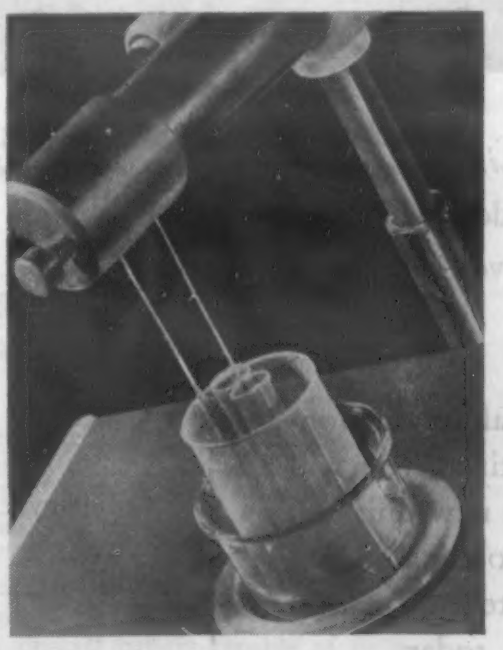

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100 diam. magnification. Light used must be approximately monochromatic, which can be obtained by filtering white light through Ilford filter micros 3 and 5 used in conjunction, or alternately, by the use of Wratten filter No. 75.

If interference fringes are used as contour lines for delineating micro-topography of finely finished reflecting surface, they must be extremely narrow and close together. This is accomplished when the angle between reflecting surface and cover glass is about ½° to 1°.

In convex surfaces, the cover glass may be fastened to the surface and the necessary conditions will be encountered close to the point of contact. In the case of a flat surface, the cover glass must be tilted at an angle of about ½° to 1°.

In the case of convex surfaces the most useful fringes to observe will be those somewhat removed from the actual point of contact. In the case of flat surfaces, it is preferable to use fringes falling near the point of contact.

Sodium lamps give monochromatic light with a wave-length of 5890 A.U., while mercury vapor a wave-length of 5500 A.U. Using Ilford micros 3 and 5, the effective wave-length is about 5850 A.U. In engineering inspection it can be assumed that whichever light is used the vertical interval will be 12 micro-in.

It is important that grease be removed from parts to be examined. This may be done with a clean duster.

—J. F. Kayser. *Aircraft Engrg.*, Vol. 16, Jan. 1944, pp. 25, 28.

Casting Test Bars

Condensed from "Foundry Trade Journal"

A test bar cast under carefully controlled conditions is recognized by the Canadian Non-Ferrous Casting Advisory Committee as being only a guide to the quality of the metal in a casting or group of castings, and in no way should its physical properties be considered as representing the physical properties actually existing in the casting. The committee condemns the practice of attaching test bars to the casting, and recommends that all test bars be cast in a separate, especially prepared, mold.

This recommendation is based on the fact that it is, in most cases, difficult to attach a test bar to a casting that will be adequately fed during solidification. It is most likely that the test bar will feed the casting or the casting feed the test bar, and such conditions are to be avoided.

The committee recommends that all test bars be made in dried sand molds without the use of facing materials to eliminate the factor of moisture affecting the physical properties of the test bar. The mold should be allowed to cool to room temperature before casting the test bar.

The committee recommends that all nonferrous alloys be melted under slightly oxidizing conditions. This procedure is

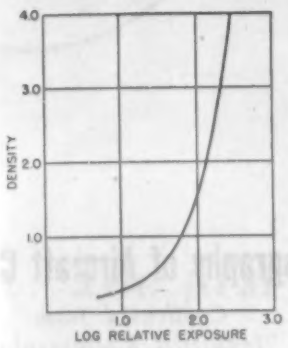
Q *Which x-ray film for*

1. Aluminum and Magnesium at low voltages?. . . and

2. Million-volt radiography of thick steel?

A *Kodak's Type "A"*

Kodak Industrial X-ray Film, TYPE A, is first choice for the examination of light alloys at lower voltages, and for the million-volt radiography of heavier steel parts, because of its fine grain and high contrast. Type A is similar in its characteristics to Type M Film—its grain is not quite as fine, but its speed, approximately three times that of Type M, makes it more widely usable.



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. . . primarily for gamma radiography, with lead-foil screens, of heavy steel parts . . . or lighter parts at low x-ray voltages.

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recognized as yielding the best results in practice. Those alloys such as the tin bronzes, and red brass which require deoxidation, should be deoxidized thoroughly with phosphor copper immediately before pouring the test bar mold.

The committee recommends that the test bars be allowed to cool in the mold for at least 3 hr. after pouring, and under no circumstances should be quenched in water or other cooling medium. The exception to this rule is test bars of heat-treatable aluminum bronze with a combined iron, manganese and nickel content of less than 3%.

Aluminum bronze with a combined iron, manganese and nickel content over 3% does not need to be quenched to develop its full physical properties.

—*Foundry Trade J.*, Vol. 72, Jan. 27, 1944, pp. 78-79.

Radiography of Aircraft Castings

Condensed from "Industrial Radiography"

Radiographic examination is valuable to the foundryman in perfecting his technique, and it enables the inspector to reject defective castings. The radiographer's knowledge should include complete structural design, uniform sections and built-up sections.

Coordination between the radiographic department, structures and foundry practice should be put into effect as early as practical. The savings in rejected material are obvious.

The technical application necessary to produce high quality radiographs must be carefully chosen, so that no flaw will escape detection. An important item is the selection of the type of film needed.

To determine percentage of sensitivity present in a radiograph, penetrameters are required. For every thickness of metal that the X-rays must penetrate, the penetrameter sensitivity shall not be less than 2% (3% for magnesium).

A film blackening or density of 1.0 provides proper sensitivity when films are viewed by cold front fluorescent illumination, but on non-uniform sections, requires a corresponding exposure for each section.

Radiographs must contain the optimum in definition. To improve this by reducing scatter, the width of the primary X-ray beam should be limited. When using calcium tungstate intensifying screens, blacking with lead shot or diaphragms or immersion of the specimen in a solution of lead acetate or lead nitrate is practically essential.

For lighter alloys, fine grain film is of great value. It also accommodates itself well to the radiography of manganese bronze, steels and brass when used in conjunction with lead-foil screens, and when the sections are not over ½-in. in thickness.

—Robert Taylor. *Ind. Radiography*, Vol. 11, Summer 1943, pp. 19-22.

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Surface Fatigue

Condensed from "Machine Design"

In this study of surface fatigue, the equipment consists of test rolls (2.2 to 4 in. diam. by maximum face width of 1 in.), or gears mounted on two shafts, one in a heavy fixed frame and the other in a swinging frame. The load between the rolls is set up by a calibrated spring.

The shafts may be adjusted to give any desired amount of slipping and rubbing between the rolls. The number of stress cycles necessary to establish surface endurance limits is very much greater than for flexural or bending endurance limits (20 to 30,000,000 cycles vs. 1 to 5,000,000).

The surface of the rolls is work hardened very much, as in cold rolling. Both the depth of cold working and the hardness increase with the number of repetitions of stress up to a maximum, which is probably dependent on load as well as on the number of stress repetitions.

The maximum hardness reading is found a few thousandths of an in. below the surface. With very plastic materials, such as soft steel and brass, under heavy loads, plastic flow may cause definite waves to form on the surface.

The input torque tends to decrease to a minimum as the test progresses and then to rise slightly after a long period under minimum torque conditions (this increase takes place before there is any indication of destructive pitting, which occurs about 1,000,000 cycles after this increase).

Material	load stress factor		
	cylinder	gear	
		14½°	20°
Semi-steel	2191	137	187
Nickel iron (300 Bhn)	1643	102	140
Nickel iron (interrupted quench)	3286	205	280
Chromium nickel cast iron	1506	94	128
Molybdenum cast iron	1917	120	163
Molybdenum cast iron (interrupted quench)	3697	231	316
Phosphorus bronze, sand cast	1177	73	100
Phosphorus bronze, chill cast	2054	128	175

These torque changes are believed to be a measure of the work done in plastic deformation. The minimum would indicate that the material has been cold worked to its limit under the specific test conditions.

An elastic wave that travels ahead of the contact and imposes reversed bending conditions on the surface lamina results, in many cases, in the development of microcracks at right angles to the direction of rolling. Small pits are evident on the surface in all cases where the loads are appreciable, regardless of whether the stresses are above or below the surface endurance limits (pits up to 0.005 in. deep and from a few thousandths to 1/16 in. across).

There are various explanations for this incipient pitting, any one of which may be true, depending upon specific test conditions, but the incipient pitting does not cause any great concern.

If the load is under the endurance limit, the pits progress up to a certain point and then cease. It is believed that the elastic wave traveling ahead of the contact is a contributing factor.

Subsurface Shear Stresses

Along with the above, shear stresses are repeatedly imposed upon the material below the surface. When the imposed loads develop stresses over the surface endurance limit, particles are sheared out of the surface of the material (particles may be ¼ in. wide by 1 in. long by 0.01 to 0.035 in., depending largely on the load intensity, number of cycles, and material).

There does not appear to be any connection between the incipient and destructive pitting; probably the sequence depends on the material and test conditions.

The behavior of plastic materials is so complex that the actual intensities of the several stresses are thus far indeterminate, but the actual test results may be and have been successfully applied to the design of cams, roller followers, gears, etc.

Calculations are given for setting up load diameter stress factors. The following values are given for various materials tested vs. a hardened steel roll: (no exact compositions or treatments given).

—E. Buckingham. *Machine Design*, Vol. 16, Feb. 1944, pp. 166-170, 243, 250.

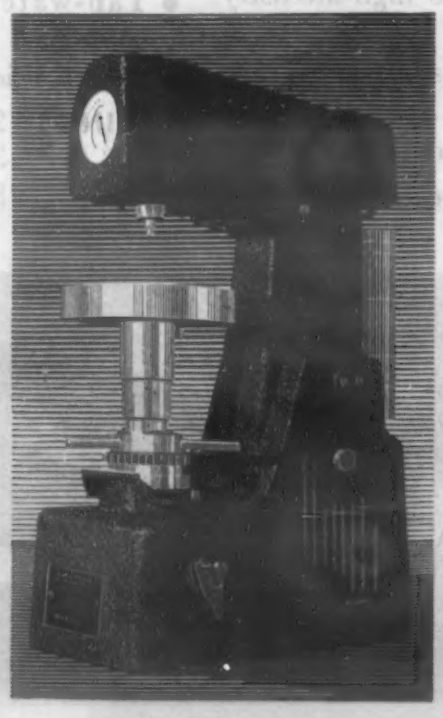
Hardness vs. Conductivity Testing

Condensed from "Zeitschrift für. Metallkunde"

Changes of electrical conductivity and hardness in relation to solid solution annealing and room temperature precipitation hardening were determined on three commercial aluminum alloys (1.02 Mg, 1.0 Si, 0.87 Mn, 0.52 Fe, 0.02% Cu, bal Al; 4.2 Cu, 0.7 Mg, 0.55 Mn, 0.3 Si, 0.45% Fe, bal. Al; and 4.5 Zn, 3.5 Mg, 0.3% Mn, bal. Al).

Within a surprisingly wide range, hardness was found to be directly proportional to electrical conductivity. It is therefore possible to replace the hardness test by a more rapid and simpler conductivity measurement on magnetic-induction basis.

—W. Köster & H. Breitfeld. *Z. für Metallkunde*, Vol. 35, Aug. 1943, pp. 163-166.



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books

FOR METALLURGICAL ENGINEERS

Ferrous Metallurgy

INTRODUCTION TO FERROUS METALLURGY. *Vol. 1, Second Edition. By Ernest J. Teichert. Published by McGraw-Hill Book Co., Inc., New York, 1944. Cloth, 5½ x 8½ in., 484 pages. Price $4.00.*

This is the introductory volume of a series used in the Pennsylvania State College extension courses. Vol. II is to deal with manufacture and fabrication of steel; Vol. III is "in preparation," but not christened.

The elementary nature of the book is emphasized by the first eight chapters, which deal with general inorganic chemistry in 96 pages, general organic chemistry in six, ceramics in 23, reactions of the blast furnace and the converter in 13, petroleum and natural gas in six, general physics in 19, electricity in 24, pyrometry in 29, metallurgical fuels and their combustion in 56 and refractories, fluxes and slags in 20. It would be necessary to examine the unpublished volumes to appraise the adequacy of the introductory 300 pages in laying a foundation for understanding what is to come later. At least, this part exposes the reader to the terminology he will meet further on.

The later chapters are on manufacture of pig iron in the blast furnace, iron founding, malleable cast iron (the reader with no knowledge of physical metallurgy will scarcely be prepared to assimilate the discussion of annealing), wrought iron, the cementation and crucible steel processes. The chapter on iron founding informs the reader that high test cast iron is made, though in the discussion of tensile compressive and shear strengths on page 149, cast iron is listed at 18,000 p.s.i. tensile.

In general, however, the statements made are as correctly made as they can be in so condensed a treatment, and the student can get from this volume a smattering of information. The book is designed for use by an instructor, each chapter ends with "questions and problems for study and class discussion." In such use it is probably adequate, especially since the introduction states that the texts have been used on thousands of students over a 10-year period. Much of the first 300 pages would be tough reading for the home student, without an instructor, nor would the text be suitable for an introductory college course in metallurgy. It ranks as a high school type of text. Were such courses to be given in high schools, it would be a usable text, as it, of course, is for its specific, extension service, purpose. It is too elementary to be a useful review text for a full-fledged metallurgist, but it wasn't planned for that.

—H. W. GILLETT

FERROUS METALLURGY. VOL. II—MANUFACTURE AND FABRICATION OF STEEL. *By Ernest J. Teichert. Published by McGraw-Hill Book Co., Inc., New York. Cloth, 5½ x 8½ in., 487 pages. Price $4.00.*

This is a Penn State extension course text. Vol. I covered the ground work; Vol. II gets into details. It covers melting practice in Bessemer, open-hearth, and electric furnaces, by direct and duplex processes, being written as if for a third helper on the open-hearth, just starting that job, and wanting to know what it's all about. The reactions and the theories involved are brought in to explain the why of each step. This painless operation is well performed, the treatment is highly practical, but the reader senses that science does underlie practice.

Pouring and soaking pit practice and the causes for defects are then discussed from a like point of view; then come hot and cold working processes, with special attention to rolling in general, and specific attention to sheet and strip, wire, and tubular products.

Special chapters are devoted to general welding methods, forging, and the steel foundry. These particular chapters are very concise and do not carry their subjects as far as is done on melting and rolling.

Under sheet and strip, hot-dipping methods of coating are discussed, but electrolytic tin and zinc coatings are not. This is about the only phase on which the fundamentals appear inadequately described for an introductory treatise of this type.

An interesting feature is that, in the sections on melting and rolling, special attention is given to handling austenitic stainless. The reader clearly understands that it is a different breed of cats from even the high quality, high alloy, ferritic steels.

The whole treatment is sane, clear, and readable. It is a very good starting point. Indeed, the practical point of view taken throughout would make it a good textbook for a regular college course in metallurgy, better than the average one written by a professor who bears down on theory. Using this as the preliminary textbook would put the student into a more receptive attitude toward a later excursion more deeply into theory.

—H. W. GILLETT

Other New Books

WELDING STAINLESS STEELS. *Published by Allegheny Ludlum Steel Corp., Brackenridge, Pa., 1943. Cardboard, 8½ x 11 in., 64 pages. Free upon request.* Allegheny Ludlum has contrived in its "Welding Stainless Steels," to turn out a booklet which presents solid facts about welding in a very uncommercial manner. The pamphlet is a real beauty. Arc welding, atomic hydrogen, oxygen-acetylene, and resistance welding are taken up in turn following a general outline of the effects of heat upon stainless steel. Each type of welding is presented pictorially, with a striking use of color. Photographs are used sparingly, but even those used seem flat after the color sketches. The effect of the various elements in standard types of stainless steels is given in the text and in several tables. The outstanding feature of the book is the very effective use of color and illustration to supplement the description of welding processes.

STEEL PRODUCTS MANUAL. *Published by American Iron & Steel Institute, New York, N. Y., 1943. Paper, 6 x 9 in., 215 pages. Price $2.50.* A new Steel Products Manual has been issued by the American Iron & Steel Institute. It describes the packaging, marking and loadon packaging, loading and shipping problems, It was prepared by the Institute's committee aided by Government officials. It is copiously ing methods destined for overseas shipments. illustrated.

METCO METALLIZING HANDBOOK. *Published by Metallizing Engineering Co., Inc., Long Island City, N. Y., 1943. Paper, 6¼ x 8½ in., 78 pages. Price $1.00.* This handbook is pointed to as "the most complete and authoritative practical treatise on the metallizing process yet published." It should prove of considerable value and aid to both engineers and metallizing operators. The five main divisions include: Surface Preparation, Spraying Technique, Corrosion-Resistant Coatings, Finishing Sprayed Metal, and Metallizing Wires.

METALLURGICAL ENGINEERING news

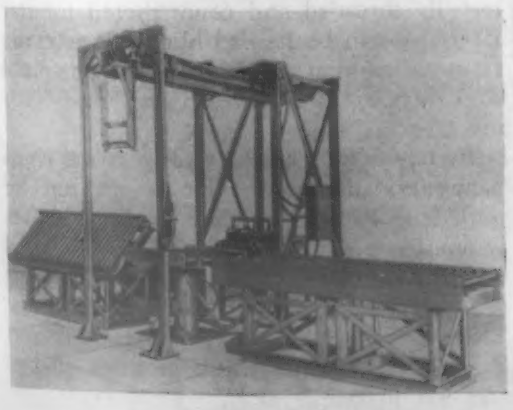
Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Automatic Feeder for Pickling

A special type of hydraulic equipment that automatically feeds processed parts to a pickling bath was developed by the *Lyon-Raymond Corp.*, 1484 Madison St., Greene, N. Y.

A large empty wire basket is placed on the tilting conveyor table, as shown in the left-hand view of the illustration. The table is tilted for convenience of loading. It is then hydraulically lowered in its horizontal position and the basket of parts rolled onto the elevating table.

An electric push button starts the following automatic sequence of operations: The table elevates hydraulically 38 in., turning 90°. At full height it starts a pusher that shoves the basket onto another roller conveyor (not shown here). The basket is then pushed into the pickle. Then the mechanism returns to its original position.



During this sequence the operator on the right side of the elevating table has readied his basket for repeating the routine. The entire cycle is accomplished in 30 sec. Limit switches and solenoid-operated hydraulic valves help in the controls.

Tensile Tester for Spot Welds

An accurate and complete check of the tensile strength of spot welds on thin sheet metal can be done in one minute on the S-A tensile tester of the *Streeter-Amet Co.*, 4134 N. Ravenswood Ave., Chicago 13.

The machine was made primarily to test the strength of veneers and thin plywoods.

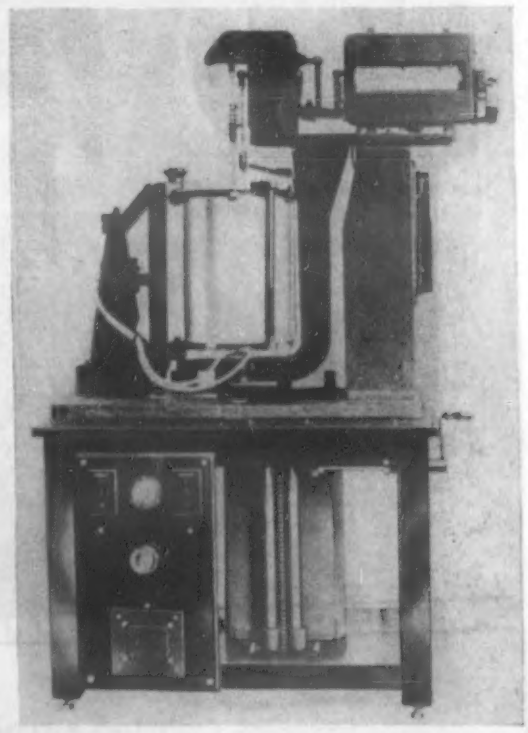
The sheet metal is dropped in the tester and held by positive clamping action. Hydraulic pressure is smoothly applied, and the breaking load in pounds pull is read directly from the dial without computation. The operators needs no special training.

Temperature-Dilation Change Recorder

A direct-reading Dilatometer that records temperature-dilation changes and temperature-time changes simultaneously in ink during heating and cooling cycles of ferrous and non-ferrous metals, ceramics and other materials is announced by the *Bristol Co.*, Waterbury, Conn.

Called the Bristol-Rockwell Dilatometer, Model A-134, it makes two records on a chart with rectangular co-ordinates for ease of interpretation and filing. The ball bearing multiplying mechanism exerts very light pressure on the sample, and provides smooth accurate records of the temperature-dilation.

The split furnace, designed for up to



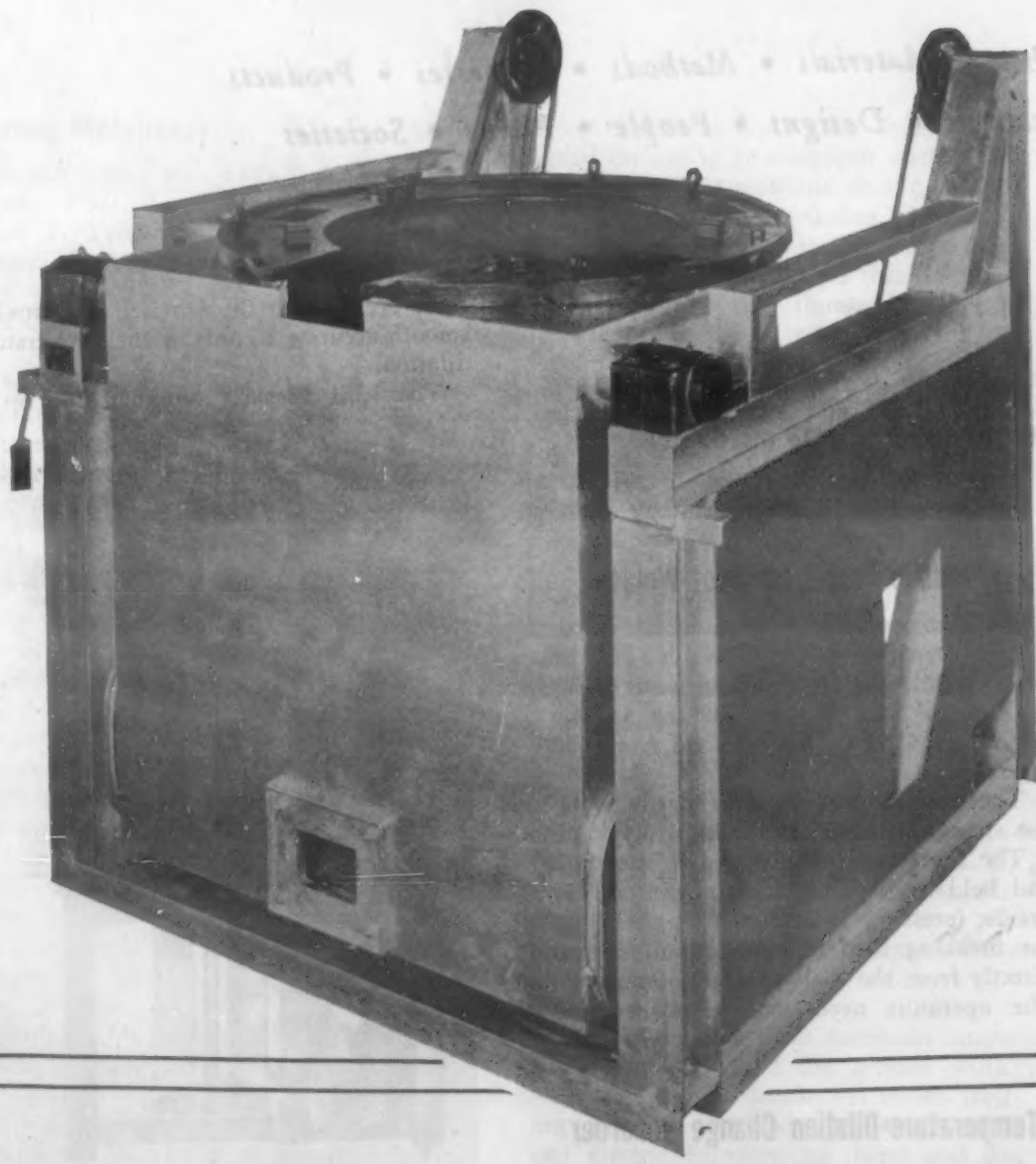
2500 F., can be pulled away from the sample for quenching or cooling without disturbing the record. Inside dimensions allow use of any size or shape of sample up to 1⅝ in. diam. by 5 in. long.

The equipment can be used to determine: Critical points of carbon steel, coefficients of expansion of metals, thermal composition of steels and heating rates, and heat saturation.

MONARCH FURNACES

for Magnesium *and* Aluminum

- *MOTORIZED NOSE POUR*
- *HAND TILTING*
- *STATIONARY*



THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

Three Cutting Metals and Tools

Some new cutting metals and tools have been announced recently. Thus, a new cutting grade of carbide, Willey's No. 910, has been brought out by *Willey's Carbide Tool Co.*, 1340 W. Vernor Highway, Detroit 1. After having been passed out to several manufacturers, reports indicate that "it is far superior to any steel cutting grades now on the market for machining tough alloy steels."

The *Jessop Steel Co.*, Washington, Pa., announces the "Malta" carbide tipped tools, a line of cemented carbides for cutting steel, cast iron, non-ferrous and non-metallic materials. They are manufactured in ten different styles in a wide range of sizes and three grades of tips, MF for miscellaneous finishing, SF for steel finishing, and CR for coarse roughing. They are rust-proofed for long storage.

Two new styles of tipped tools for machining steel have been announced by *Haynes Stellite Co.*, unit of Union Carbide & Carbon Corp., Kokomo, Ind. Style P and Q consist of a cutting tip of Stellite 98M2 cobalt-base alloy brazed or butt-welded to a tough steel shank, with proper clearance and lead angles ground for turning steel.

They are especially suitable for tools that have a large cross section or tools that are bent or offset, or for tool holders that make the use of solid tool bits impractical. They are used in turning, boring, facing, forming and grooving.

P is a right-hand tool; Q, a left-hand tool. Five sizes of each tool are stocked.

● A line of instruments to enforce any desired heating or cooling program is announced by *Wheelco Instruments Co.*, Harrison & Peoria Sts., Chicago 7. Named Chronotrols, they are built around the company's pyrometers, potentiometers, thermometers and resistance thermometers, all employing electronic control. Temperature cycle desired is cut on a disc and its rotation by a synchronous motor moves the temperature setting lever of the control instrument. They are offered in 25 models.

Blind-Headed Rivets

The patented "Rivnut" of the *B. F. Goodrich Co.*, Akron, Ohio, originally for aeronautical uses, is now available for many industrial applications. It is an internally threaded and counterbored tubular rivet that can be headed blind. It is made from aluminum alloys, is of one-piece construction, is anodized, and ready for use.

By one of the special tools that the company also distributes, the Rivnut can be pulled up or headed while working entirely from one side, forming a bulge or head on the far side. Installed, the Rivnut serves as a nut plate or rivet, or both. There are two head styles, countersunk and flat, with the countersunk in three shapes and flat in one.

Among its many applications are air-conditioning units, stoves, refrigerators, radios, panels, shipbuilding, etc. Original use was attaching De-Icers to airplanes.

A Key to BETTER MAINTENANCE

Day and night operation, excessive wear, and today's replacements difficulties demand *better maintenance* of equipment.

A key to better maintenance is *better lubrication.*

In addition to a complete line of quality cutting oils for all metal working operations, Sinclair offers a range of specialized oils and greases for better lubrication of *MACHINING EQUIPMENT.*

Sinclair General Purpose Oils permit a reduced inventory of lubricants highly efficient for turret lathes, automatics, broachers, shapers, grinders and machine tools generally.

Where top loads and continuous operation threaten shorter life for motors, mechanical drives, and all types of bearings, Sinclair lubricants make for *better maintenance.* Consult us about your lubrication problems.

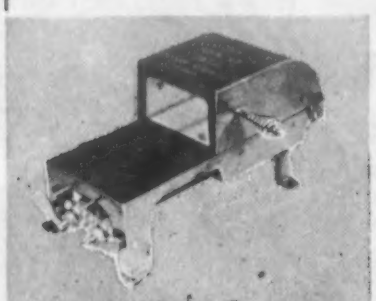
(Write for "The Service Factor" — published periodically and devoted to the solution of lubricating problems.)

SINCLAIR INDUSTRIAL OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY (INC.), 630 FIFTH AVENUE, NEW YORK 20, N. Y.

Install Speedy, Economical Johnson Furnaces in Your Plant Now!

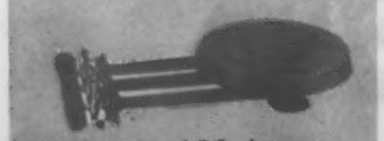
They'll save you time and money—now and later, so get them operating now. We'll deliver in ONE WEEK.



No. 101 Bench Furnace
2 burner—$13.50

No. 70 Hi-Speed Steel Heat-Treating Furnace $89.50

No. 34 Adjustable Pre-Heating Torch $40.00



No. 40 ABC Atmospheric Ring Burner $16.25

No. 130-A—Hi-Speed Steel Heat-Treating Furnace. Model illustrated has four burners and is designed for temperatures from 1400 to 2000°F., and is priced complete at $295 F.O.B. Factory. 6-burner unit is for 1800 to 2400°F., and is $325 complete, F.O.B. Factory. Firebox is 7" high, 13" wide and 16¼" long. Counterbalanced door opens upward, so tools can be placed or removed without temperature drops. You'll want 130-A!

No. 130—Heat-Treating Furnace for Hi-Speed Steels. Has firebox 5½" high, 13" wide and 13½" long. Gives you quick, high, accurate temperatures. Carbofrax hearth, heavy insulating refractory lining, G.E. motor and extra large Johnson blower. $248 F.O.B. Factory.

No. 120—Hi-Speed Steel Heat-Treating Furnace with firebox 5" high, 7¾" wide, 13½" long. Reaches 1500°F. in just 5 minutes. Exceptionally fine for treating hi-speed steels, hardening punches, dies and tools. Equipped with G.E. motor and Johnson Blower. Heavily lined with insulating refractory. Carbofrax hearth. $129.50 F.O.B. Factory.

No. 575—Pot Hardening and Melting Furnace. Fitted with automatic lighting device. Heavily insulated with 4½" firebrick, backed up with 3½" insulating block. Lid-lifting mechanism easily raises cover and locks it in UP position. Steel pot 14" wide, 20" deep. Complete with Blower. Also available with pots 14x16 and 14x18.

Parts and Patterns Are Still Available for Every Johnson Unit Ever Built

Write today for Price List of Parts

SALES OFFICES:

120 Liberty St., New York 6, N. Y.
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JOHNSON GAS APPLIANCE CO.,
621 E Ave. N.W., Cedar Rapids, Iowa
Please Send Me New Johnson Catalog

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Address .....
City .....
State .....

Heater for Shrink Fit Application

A low frequency induction heater built by the *American Car & Foundry Co.*, 30 Church St., New York, has been slightly

modified from standard units to heat the work horizontally as against the standard vertical method. This particular unit is for heating crankshafts for airplane engines.

The shaft, 4¼ in. in diam. by 10 in. long, with tapering walls about ⅜ in. thick, is heated to 400 F., so that frozen bushings can be slipped in, and when at normal temperature shrink firmly into position.

The unit is a 44-Kva. transformer, with secondary voltage running from 2 to 10. It is 18 in. wide by 2 ft. 10 in. long and 1 ft. 7 in. high. The crankshaft is placed on a sliding carriage, moved in to be heated and then withdrawn.

It has a timing mechanism and automatic device that turns on the water before the current can go on. When current cuts off, it cuts off the flow of water to protect the coil.

● Evaporative condensers with built-in air filters to protect against impurities in the cooling system are now available in the new Wat-R-Miser line of *Drayer & Hanson, Inc.*, 738 E. Pico St., Los Angeles 21, Calif. The units effect heat transfer by water evaporation in a continuously moving airstream. They cool batch quenching fluids, oil for large Diesels, jacket water, etc. Air filtering tends to prevent clogging of lines, plugged spray nozzles, excessive head pressure and pump maintenance.

A.C. Welders Used for Demagnetizing

The widely expanded use of highly hardenable alloy steels has made many instances where permanent magnetism has caused trouble in arc welding, as well as in the operation of tools. Often metal parts cling to dies that had become magnetized. Jewelers have often found it imperative to demagnetize watches.

R. F. Wyer, *General Electric* welding engineer, reports that G.E. a.c. arc-welding transformers, equipped with stepless control, have accomplished demagnetizing.

Thus, in the case of a die, 5 or 6 turns of cable are wrapped around the die. A heavy 60-cycle alternating current from a 500 amp. welder is passed through the cable, the current being gradually decreased by turning the current-control crank on the welder. This demagnetizes the die.

You'll want this up-to-date review of

ORDNANCE FLAME HARDENING

Send for free copy now

THIS 12 page booklet gives a concise, illustrated review of the latest applications of flame hardening in ordnance production. It describes both manual and machine methods now being used — progressive hardening, simultaneous hardening and tempering — and gives factual data on the equipment employed and results achieved.

If you want to keep posted on the uses of this modern surface hardening method for either immediate or post-war use in your plant, be sure to mail the coupon for your free copy of "Ordnance Flame Hardening". Please indicate the minimum number of copies you want to receive. We'll forward them promptly.

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MOUNTED WHEELS
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GRINDING WHEELS

A complete range of styles, grains and sizes up to 3" in diameter to give you a perfect finish on every job.

PROMPT DELIVERY

Specialization — with full WPB approval—on sizes 3" in diameter and under, means no waiting for Chicago Grinding or Mounted Wheels. Let us take care of your present and post-war requirements.

YES, YOU CAN FINISH IT BETTER WITH A CHICAGO WHEEL

As the prelude to a new world of better tools of war, so the prelude to a perfect finish is better grinding wheels.

Today's standards of finishes are far and beyond those of yesterday. To acquire them without sacrifice of production time is a goal which everyone seeks.

Finish must now be measured in micro inches. That's where the new Chicago **FV BOND** Wheels excel. They give a precision smoothness so intensified that it passes any surface analyzer test, in many cases eliminating hand lapping and auxiliary finishing operations.

FREE Engineering Analysis

If you have a grinding job that presents a problem because of the nature of material, tricky shape or other reason, tell us about it. Our experts will go into a huddle and give you the benefit of our long experience making millions of custom built wheels for every conceivable operation.

HERE'S WHAT MAKES CHICAGO WHEELS CLICK—

A—Sensational new FV BOND. Result of research and experiment on hundreds of aircraft jobs.

B—No sacrifice of cutting time or wheel life.

FV BOND is available in all types of Chicago Mounted and Small Grinding Wheels—in all abrasives, grain and grade combinations.

TEST WHEEL FREE—To prove their superiority in your own shop, send for a Chicago Wheel made with **FV BOND**. Give us details of the job, material you want to finish and we'll do the rest.

Write for Catalog and Interesting Engineering Survey Form

CHICAGO WHEEL & MFG. CO.

1101 West Monroe St., Dept. ME, Chicago 7, Ill.

Half a Century of Specialization has Established our Reputation as the Small Wheel People of the Abrasive Industry.

New Superior Plating

Certain copper or brass parts of aircraft instruments that carry high frequency currents must be corrosion resistant. Nickel has high electrical resistance. Gold is too costly.

Westinghouse engineers made special plating anodes of an alloy of copper, tin and zinc, which can be applied by standard plating practices.

Results are said to be amazing. The surface has proper electrical conductivity for high-frequency applications, and is far superior to nickel in corrosion resistance. The finish is mirror-like, surpassed only by silver.

The new plating resists abrasion, is non-magnetic, and is easily soldered. Deep interior surfaces are plated much more uniformly than is possible with nickel.

● A new marker for icy, wet, sleek or oily metal surfaces is "Paintstik," put out by *Markal Co.*, 6 E. Lake St., Chicago. Designated as "Markal B," it is for shipyards, steel mills and all other outdoor locations. Many steel plates possess magnetic oxide surfaces, which when exposed to cold rain or fog, produce wet, sleek surfaces difficult to mark. Markal B has all the properties of liquid paint, yet is handy and clean as a pencil.

Hydrostatic Test Press

A new hydrostatic test press for determining strength of materials, design, etc. is announced by *Denison Engineering Co.*, Columbus, Ohio. It simplifies testing of drawing qualities of metals, fatigue in metals and alloys, influence of heat treatment, and facilitates comparison of welding methods.

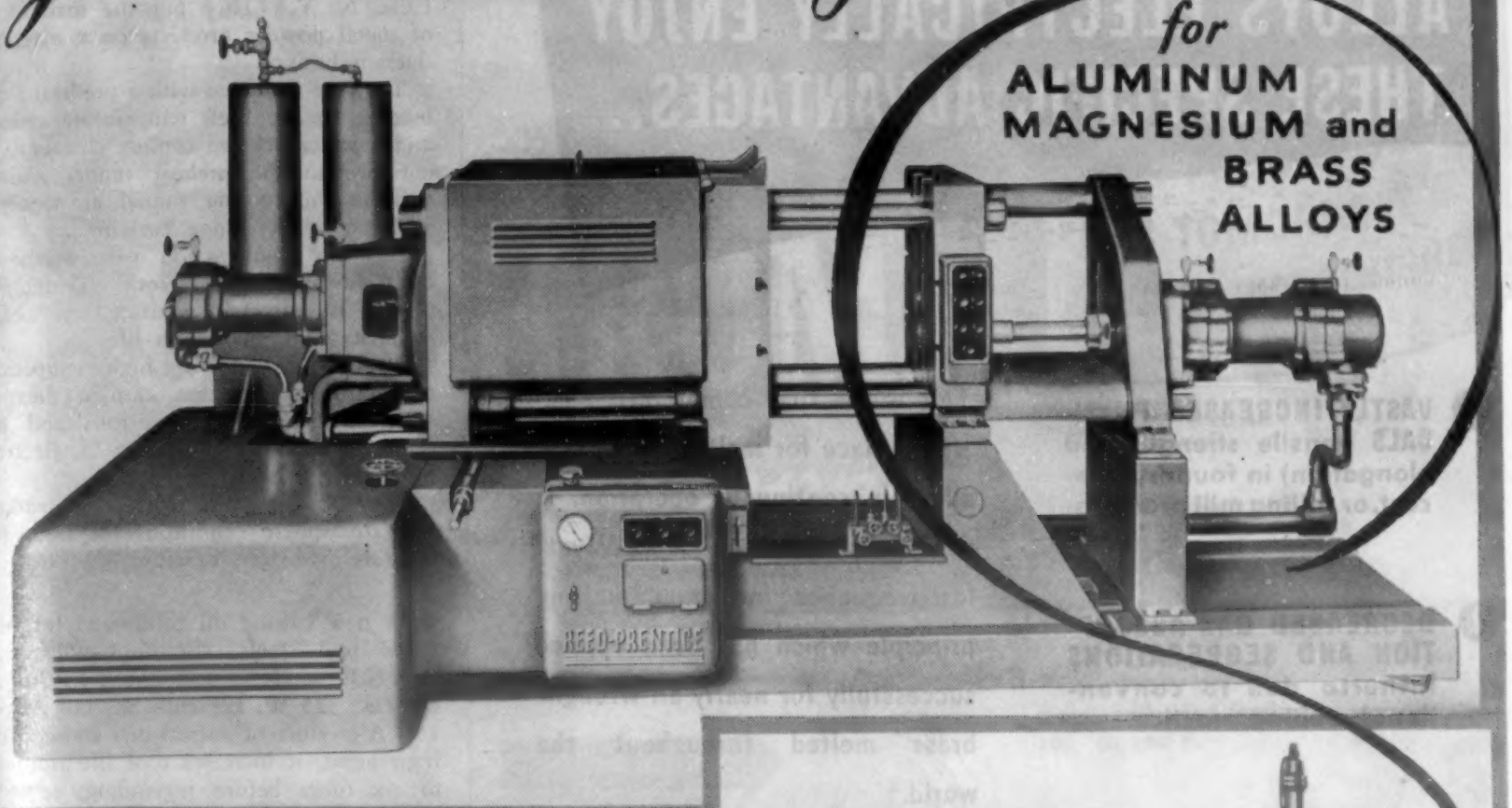
Coatings for metals, such as paints, enamels and plastics, can be tested by alternate applications of pressure, simulating expansion and contraction. Strength of all types of containers and rapid porosity and seepage values are obtained accurately.

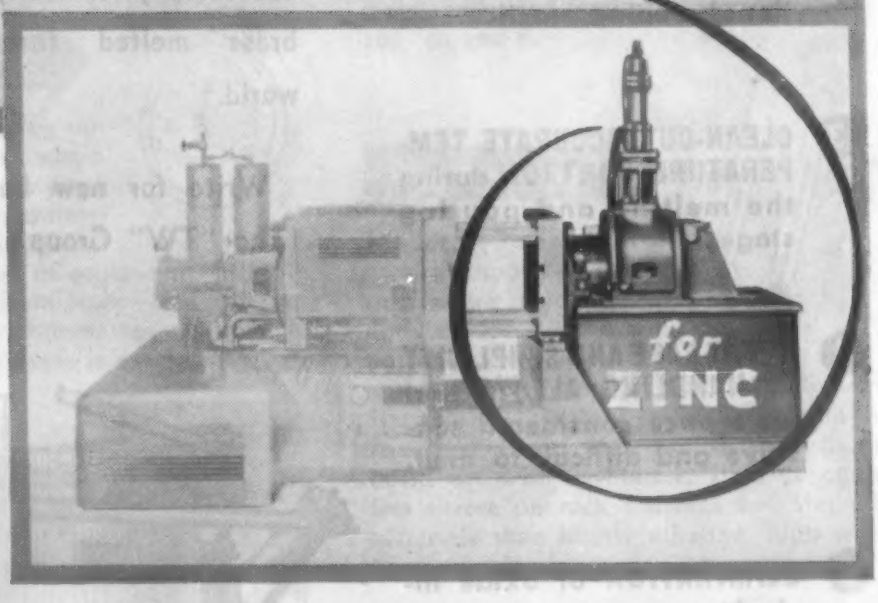
Impregnation of aluminum-magnesium alloys by boiling or soaking in liquid

should be accomplished more efficiently under pressure possible with this test press.

The clamping portion of the machine makes it possible to test articles of various heights without retooling.

Greater Flexibility IN DIE CASTING





No. 1½G REED-PRENTICE High Pressure Cold Chamber Die Casting Machine

• •

Design and construction of these new and improved die casting machines provides for quick change from 1½G type for use with Aluminum, Magnesium and Brass Alloys, to 1½ type for Zinc, Tin or Lead Base Alloys, or vice-versa. Cold Chamber Attachment or Furnace Attachment can be purchased separately, thereby keeping investment cost to a minimum where but one machine is desired. Change from one type to the other is readily made in but 4 to 5 hours.

SPECIFICATIONS:	No. 1½G	No. 1½
Size of die plates	28" x 29"	28" x 29"
Space between bars	15" x 18"	15" x 18"
Dies Open	10"	10"
Maximum die space	18"	18"
Minimum die space	6"	6"
Capacity melting pot (Zinc)	——	700 lbs.
Weight	12,500 lbs.	15,500 lbs.
Motor, H. P.	15	15

Send for circulars of these new No. 1½G and No. 1½ Die Casting Machines, also larger No. 3G High Pressure Cold Chamber type machine.

No. 1½ REED-PRENTICE Die Casting Machine

FEATURES:

One-piece welded base and hydraulic tank.
Improved linkage with electric steel members, nitrided pins and hardened steel bushings.
Heavy steel castings for die plates.
Improved hydraulic circuit to increase speed of cycle.
Electrically operated hydraulic control with new control panel.
Both manual and semi-automatic control with electric interlock for operator's safety to prevent shooting of metal until dies are securely closed.
Arrangement for automatic ejection of castings and ready application of core pulling cylinders for operation thru electric pushbutton station.

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PLANTS NOW MELTING ALUMINUM ALLOYS ELECTRICALLY ENJOY THESE SPECIFIC ADVANTAGES...

1. **VASTLY INCREASED PHYSICALS** (tensile strength and elongation) in foundry, die-cast, or rolling mill products.

2. **DECREASED GAS ABSORPTION AND SEGREGATIONS** hitherto due to conventional melting practice.

3. **CLEAN-CUT, ACCURATE TEMPERATURE CONTROL** during the melting and pouring stages.

4. **GREAT EASE AND SIMPLICITY IN HANDLING ALLOYS** that were once considered sensitive and difficult to melt.

5. **ELIMINATION** of oxide inclusions.

6. **COOL AND CLEAN** foundry operations.

7. **DELIVERY** of the rated production per hour on the hour, (production capacity 300 lbs. to 1250 lbs. per hour).

This is the first commercial electric furnace for melting aluminum alloys in continuous operation. It utilizes the famous Ajax-Wyatt low-frequency induction melting principle which has been applied successfully for nearly all wrought brass melted throughout the world.

Write for new bulletins . . .
(The "TW" Group)

F-55

AJAX ENGINEERING CORPORATION, Box 1418, Trenton 7, N. J.

THE AJAX TAMA-WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Holtgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

Furnaces for Sintering Powdered Metal

A line of high temperature electric furnaces for sintering powdered metal at 1800 to 2750 F. is announced by the *Harper Electric Furnace Corp.*, Niagara Falls, N. Y. They put the manufacture of metal powder products on a mass production basis.

They are equipped with a pre-heat tunnel leading to the high temperature chamber and a water-jacketed cooling chamber. The entrance to the preheat tunnel and the exit on the cooling tunnel are equipped with automatic flange curtains.

Gas-tight construction permits the use of protective atmospheres. Temperature control is extremely accurate, and heating elements enjoy maximum life.

Applications include high temperature cementing of tungsten carbide dies and sintering of powdered ferrous and non-ferrous metal parts, heating of electronic tube parts, etc.

They also provide correct temperature and atmosphere conditions for high temperature hydrogen brazing.

● A new cutting oil compound for high-speed tool steels, chromium-molybdenum and N.E. steels is announced by *Fearless Oil Co.*, 325 W. Eleventh St., Los Angeles 15. A mixture of animal oils and chemical ingredients, it increases tool life from two to six times before regrinding, steps up production 25 to 100% and gives a superior finish. It is especially good for tapping operations.

Micrometer Stop Countersink

A large micrometer stop countersink for precision countersinking of large rivets, bolts and screws has been brought out by the *Aero Tool Co.*, Burbank, Calif. It countersinks up to 1¼ in., and can handle up to ½-in. rivets.

It can be locked instantly and positively at each micrometer setting in increments of 0.001. Manual adjustments can be made while the tool operates.

It includes precision ground interchangeable 1-in. diam. cutter, available in 72, 78, 82, 100 and 115° angles, with or wthout integral pilot.

Plants and Slants

The *Waterbury Button Co.*, Waterbury, Conn. will hereafter be known as *Waterbury Companies, Inc.*, the change having been made because of more widely diversified activities of the company. The organization stems back to 1812, when Aaron Benedict, one of the earliest of the Connecticut brass manufacturers, built a small mill on the Mad River and made brass and pewter buttons and other small metal products. In fact, this may be said to have been the beginning of the Waterbury brass industry. In recent years, the company has made many plastic products as well as metal.

Monsanto Chemical Co. has purchased *I. F. Laucks, Inc.*, Seattle, manufacturing chemist and producer of plywood glues.

IF YOU USE COPPER PLATING AND WANT THE BEST!

See what you get in the new

UNICHROME

Alkaline Copper

-FOR TODAY'S WAR PRODUCTION
-FOR TOMORROW'S DECORATIVE FINISHES

After selecting Unichrome Alkaline Copper to meet today's war needs, users of this process found they had an "ace in the hole" for post-war requirements. Speed . . . efficiency . . . smoother deposits . . . safe operation . . . all these advantages, proved in many large installations will pay immediate dividends when it's time to switch to decorative applications.

Here in a nutshell is the combination of characteristics that makes Unichrome Alkaline Copper *the process* for plants that use copper plating and want the best:

LUSTROUS DEPOSITS

Copper can be deposited quickly and easily to required dimensions.

The extreme smoothness of the deposit provides an excellent base for bright nickel *without polishing or buffing.* When the base metal does not have the required degree of polish—and buffing is needed—the plate buffs easily and with minimum pressure.

FAST PRODUCTION

Installations are being operated at speeds which give .001" of copper plate in less than 20 minutes—yielding greatly increased production per unit of equipment. Deposit is "active"—free from scum—and requires no treatment for subsequent plating. A standard cleaning cycle is employed.

NO SPECIAL EQUIPMENT

The process can be used with all types of equipment including still tanks, automatic and semi-automatic conveyors and barrels. The solution is non-toxic, and does not attack clothing or equipment. *It contains no cyanide,* gives off no objectionable or injurious fumes and requires no ventilation. Brighteners, wetting agents or special addition agents are not needed.

The bath is stable, has a wide operating range and uses moderate temperatures—100° to 140°F.

IMPORTANT SAVINGS

Moderate temperature means important savings in heating requirements and heat losses. Throwing power is excellent—anode and cathode efficiencies are 100%. Replenishment cost is low because solution is free-rinsing and does not deteriorate or build up with carbonate. Bath is much less severe on rack coatings and stop-off materials than highly alkaline, high temperature solutions.

INVESTIGATE!

Here is a leaflet that tells you *all* the unique advantages of this process. Write for it now—giving a brief outline of your requirements.

OTHER U. C. PRODUCTS AND PROCESSES TO SERVE YOU

CHROMIUM PLATING for wear-resisting, oil-retaining and other types of finishes.

☆**ANOZINC** for anodic treatment of zinc giving greatly increased corrosion-resistance and an attractive black or yellow finish.

☆**UNICHROME ALKALINE ZINC** for smooth, lustrous zinc plating in a non-cyanide bath.

☆**UNICHROME ALKALINE STRIP BATH** for speedy removal of copper, chromium, zinc, etc., from steel and cast iron without etching the base.

☆Trade Mark Reg. U. S. Pat. Off.

☆**UNICHROME RACK COATINGS** specially formulated to stand up under the most severe operating cycles.

☆**UNICHROME STOP-OFF LACQUERS AND COMPOUNDS** specially formulated to meet specific plating problems.

☆**UNICHROME CLEAR LACQUERS** specially formulated to meet specific finishing requirements.

☆**UCILON**—a corrosion-resistant material for protecting surfaces against acids, alkalies, water, gasoline and various corrosive chemicals.

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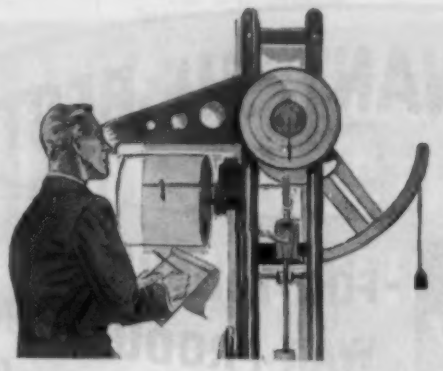
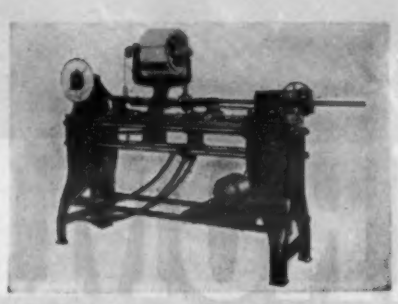


60 models of *Scott Testers



Model Q-7 Scott Tester. Heavy duty tensile tester for wire with capacity of 2,000 lbs.

The 60 models of *Scott Testers meet the needs of the Wire Industry for tests for tensile, hysteresis, flexing, compression-cutting (of rubber covering) and other tests. Scott testing methods conform to (or actually set) accepted standards, the results being provided in the form of easily read, picturized charts. Capacities are available from finest filament wire to 1 ton.

Request Bulletins

HENRY L. SCOTT CO.

65 Blackstone St., Providence, R. I.

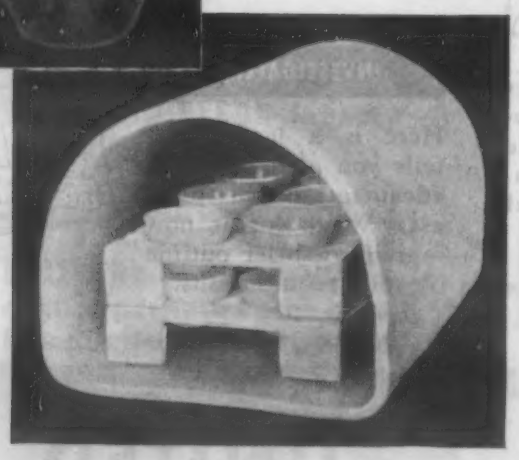
SCOTT TESTERS

*REGISTERED TRADEMARK

Scott Testers — Standard of the World

TRANSPARENT VITREOSIL CRUCIBLES

with accurately ground-in lids— for COAL and COKE ANALYSIS



- ***Replace platinum in many instances***
- ***Superior to porcelain***
- ***Duplicate plant practice.***

Vitreosil crucibles are particularly suitable for determining volatile and combustible material in coal and coke, or the volatile constituents of carbon black; and for weighing, following ignition, of hygroscopic precipitates such as alumina.

Transparent Vitreosil gives long service in continuous use at temperatures up to 1000-1100°C., readily withstanding extreme and rapid temperature changes because of its unique low thermal expansion . . . Is practically immune to injury by impurities in coke . . . also unaffected by halogens and acids other than fluorine, hydrofluoric, and phosphoric, and is indifferent to the action of all but highly alkaline reagents.

VITREOUS SILICA — VITREOSIL REG'D TRADE MARK

THE THERMAL SYNDICATE, LTD.

12 EAST 46th STREET, NEW YORK 17, N. Y.

The company began with development of soybean glues, and has continued down to the present synthetic resin glues.

The new steel plate mill of the *Geneva Steel Co.*, near Provo, Utah, started operations on March 23, the plates to go largely to the Pacific Coast shipbuilders. The plant started operating in less than two years after the ground was broken on 1600 acres of farmland. Coal is mined in Horse Canyon, 130 miles southeast of the plant; iron ore comes from an open pit mine in southwestern Utah, 250 miles away, while limestone and dolomite are obtained near Payson, Utah, 25 miles distant.

National Calibration Service, Brooklyn, N. Y. has been purchased by *Foster D. Snell, Inc.,* consulting chemist and engineer, 305 Washington St., Brooklyn 1, N. Y. The principal business of National has been verification of vertical compression and tensile testing machines.

The *Ohio Stainless Steel Co.* has been formed, with offices at 1048 Union Commerce Bldg., Cleveland, to specialize in all types of stainless steel products, including bars, plates, special shapes, strip, sheets, wire and tubing.

The annual financial report of the *National Malleable & Steel Castings Co.* reveals that an expansion of the Cicero, Ill. malleable foundry was begun late in 1943 that will virtually double its capacity by adding and rearranging equipment. Improvements in melting and heat-treating equipment at three steel foundries now enable the company to produce any type of alloy steel, and its research divisions are working on the design of lighter transportation equipment by use of alloys.

Ernest G. Jarvis, president, Niagara Falls Smelting & Refining Corp., Buffalo, has been appointed to the war control termination committee of the National Association of Manufacturers.

News of Engineers

Clyde Williams, director of the Battelle Memorial Institute, Columbus, O., has been engaged as technical consultant by the Association of American Railroads. He will coordinate and organize research relating to the technological methods and processes. Widely experienced in industrial research, Mr. Williams is chairman of the War Metallurgy Committee. His office will be at 59 E. Van Buren St., Chicago.

Walter S. MacNabb, who took part in the development of the world's largest steel mill, the Gary works of Carnegie-Illinois Steel Corp., has been appointed division superintendent of the plant's blast furnaces. He spent many years in India, helping develop the Tata Iron & Steel Co. plant at Jamsphedpur, major steel producer of the British Empire. He was closely associated with the late John Keenan, author of the recent best seller, "Steel Man in India," who was manager of the Tata plant.

Roger F. Waindle, formerly chief of tank and automotive production, War

ALMOST RIGHT
IS WRONG
SMITHway
Electrodes
in Action
All-welded Diesel engine bases produced in quantity by A. O. Smith for our powerful two-ocean Navy.

WHEN you are up against the "buzz saw" of important service, you want electrodes that have been proved practical by shop experience—backed up, of course, by sound research and engineering.

SMITHway Certified Welding Electrodes are reliable *production tools*, thoroughly proved by day-to-day application in our own shops. With us "Almost right is *wrong*." We must have dependable *quality*, dependable *uniformity*, and the right *operating characteristics* in the electrodes we use. "Almost right" is not good enough. That's why we make the welding electrodes used in our own plants.

Since there isn't any kind of arc welding we don't do, and since there are many kinds of arc welding done only in our shops, SMITHway Certified Welding Electrodes are *proved* in every type of arc welding operation. That, we believe, assures *better welding results* in your shop. We know it does in ours.

Mild Steel . . . High Tensile . . . and Stainless Steel
WELDING ELECTRODES
made by welders . . . for welders

SMITHway A. C. Welding Machine saves power; eliminates arc blow.

SMITHway Welding Monitor trains better welders faster.

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Dept., Chicago district, has been released to the Alloy Casting Co., Champaign, Ill., engineers and manufacturers of furnace mechanisms and heat-resisting alloy castings, to become general manager and chief engineer.

Samuel L. Case, formerly technical advisor, Jones & Laughlin Steel Corp., is now associated with Battelle Memorial Institute, Columbus 1, as a research metallurgist. He received his technical education at the Polytechnic School of Kiev, Russia. He will now be engaged in research in process metallurgy.

John Fetcher, formerly chief electrical and welding engineer, Edward G. Budd Mfg. Co., Philadelphia, has been made head of the methods and equipment department of that company. *Robert Phair* succeeds Mr. Fetcher.

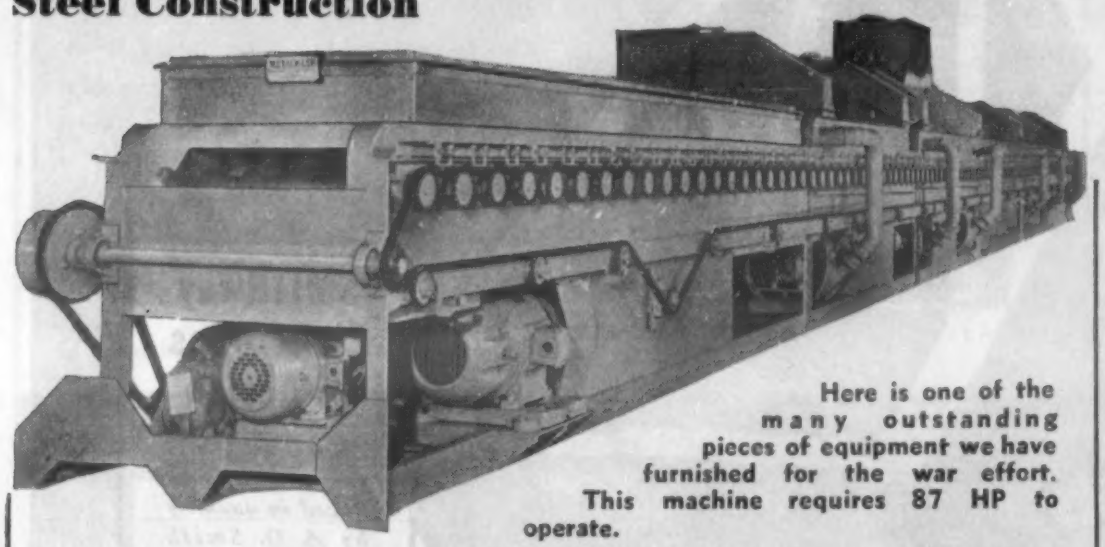
John F. Robb has been made manager of the Pittsburgh district of the Climax Molybdenum Co. He was graduated from Penn State College in metallurgical engineering in 1927. He has been with Carpenter Steel Co., Birdsboro Steel Foundry & Machine Co., Pittsburgh Crucible Steel Co., and Brighton Electric Steel Casting Co.

Gerald A. Lux has joined Oakite Products, Inc., New York, where he will conduct research studies on metal surface preparation and finishes and do field work in an advisory capacity.

Dr. V. N. Krivobok, authority on stainless steel and former professor of metallurgy at the Carnegie Institute of Technology, has become associated with the development and research division, International Nickel Co., at New York.

C. F. Nagel, Jr., chief metallurgist, fabricating div., Aluminum Co. of America, becomes chief metallurgist and will head a new metallurgical division. He will be succeeded by *T. W. Bossert,* assistant chief metallurgist of fabricating. *C. L. Dunham* becomes chief metallurgist of the reduction division. *H. J. Rowe,* manager of the general technical laboratory of the castings division in Cleveland, is now chief metallurgist of that division, but with headquarters at Pittsburgh.

Ninety Feet *of* Stainless Steel Construction

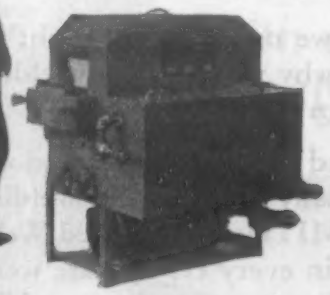


Here is one of the many outstanding pieces of equipment we have furnished for the war effort. This machine requires 87 HP to operate.

We show by comparison, in the illustration below, our MIDGET Wash Unit which is powered by a ¾ HP motor.

These two machines, contrasting so much in size and capacity, gives an idea of the range and scope of the Metalwash Company's engineering and construction facilities.

If you have either simple or complicated cleaning problems in your production lines, or pickling, bonderizing, drying—any combination of metal finishing difficulties, we may be of exceptional service to you due to our long experience and our wide knowledge of this field. We cordially invite your inquiry.



Our Special Illustrated FOLDER will be sent to you on request.

METALWASH
MACHINERY COMPANY
149-155 Shaw Ave. Irvington 11, N. J.

Briefs on Associations, Promotions and Education

The "Magnesium Association" has been formed, with a temporary address of 2537 W. Taylor St., Chicago 12, a chief purpuse being to "give members and the public authentic information as to the properties and advantages of magnesium alloys and suitable type of applications." Edward S. Christiansen, vice president, Apex Smelting Co., has been elected president; C. C. Loomis, president, New England Lime Co., is vice president; C. E. Larson, operations manager, White Metal Rolling & Stamping Co., is treasurer. There are over 100 companies engaged in fabrication of magnesium and alloys, by drawing, forging, rolling, extruding, sand casting, permanent mold and die casting, and powder manufacture. Exhibits of articles fabricated of magnesium are planned for the association's annual meetings, the public to be invited.

The National Tool & Die Manufacturers' Assn. is planning an advertising campaign to make better known the part played by makers of tools, dies, gages and molds in mass production and explain the wartime achievements of the 4,000 shops in the industry.

The Steel Shipping Container Institute, Inc. was formed recently, selecting for president Livingston B. Keplinger, vice president of Rheem Mfg. Co. Its objectives will be the advancing of the industry, and carrying on of research. The following vice presidents were elected: H. N. Lees,

DoALL

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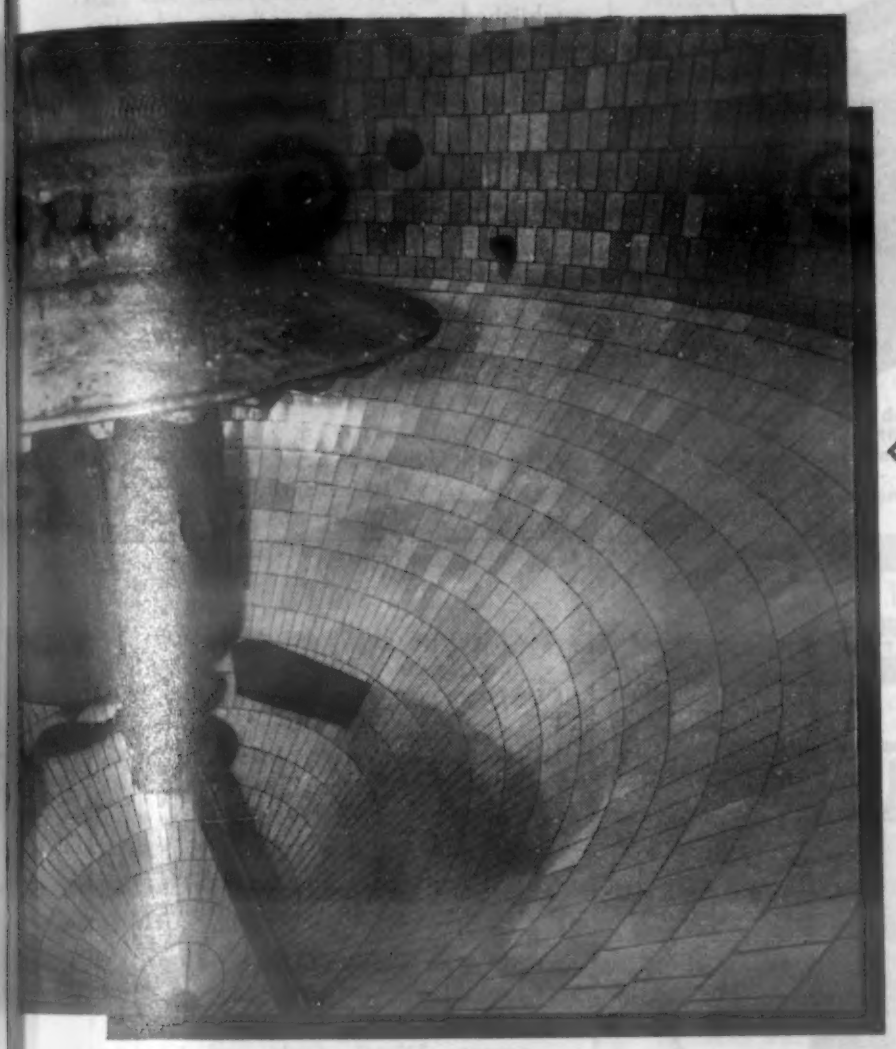
THE DoALL COMPANY, Des Plaines, Ill.

Sales & Service Offices: Baltimore, Boston, Chicago, Cleveland, Denver, Detroit, Erie, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Orlando, Philadelphia, Pittsburgh, Portland, Rochester, Rockford, St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, Toledo, Tulsa, West Hartford.

Gentle AS A TWO-TON BLOCKBUSTER!



THAT'S WHAT FIGHTING CORROSIVES ARE TO EQUIPMENT AND CONTAINERS OF ORDINARY, EVERYDAY CONSTRUCTION

BUT HERE is Chemical Processing Equipment that shrugs off their worst attacks!

Its daily diet may include fighting acids, organic solvents, corrosive salt solutions...plus punishing abrasion, erosion and abrupt temperature changes • It is ATLAS designed and constructed of acidproof ceramic blocks, joined with

Carbo-KOREZ

...a synthetic resin binder and acidproof powder, mixed on the job to make the acidproof cement. *Carbo*-KOREZ is easy to use and obtains its permanent set in approximately fifteen hours at normal temperatures.

• *Carbo*-KOREZ is one of a group of FIVE ATLAS ACIDPROOF CEMENTS which between them, cover the entire field of industrially-used corrosives and other fighting chemicals • *Carbo*-KOREZ withstands temperatures to 360° Fahr., and is inert to such hard hitters as Sulphuric, Hydrochloric, Phosphoric, Hydrofluoric, Acetic, Lactic and many other organic acids; also to alkalis such as Sodium Carbonate, Calcium Hydroxide, Ammonia ...and to solvents, fats and oils.

• ALKOR—a new resin cement of the KOREZ series—is inert to *all* alkalis of *all* concentrations, as well as to acids and solvents, making it possible to use the same equipment for Alkali and Acid Processes.

Write for this Informative TECHNICAL BULLETIN No. TV-9A

It tells how you may have the correctly designed and "materialed" acidproof units your particular problem calls for, in actual service with minimum loss of time. Our Engineering Division is ready to assist you with recommendations, plans and estimates. Address us here at Mertztown for bulletin. Our nearest technically trained representative may be reached at one of the addresses at left.

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Time saving procedures, using Coleman Spectrophotometers* are shown in the new and revised "Curves and References." Molybdenum, phosphorus and manganese references are also given.

One user reports "...*copper, nickel and molybdenum determinations are done in 20 minutes using the UNIVERSAL, as compared to 90 min. formerly required.*"

Write for Bulletin M-5 and ask also for detailed procedure on the new copper and nickel method!

Turning one knob permits selection of any color light band required—Coleman Universal Spectrophotometer at $340.00 — replaces visual and filter colorimeters.

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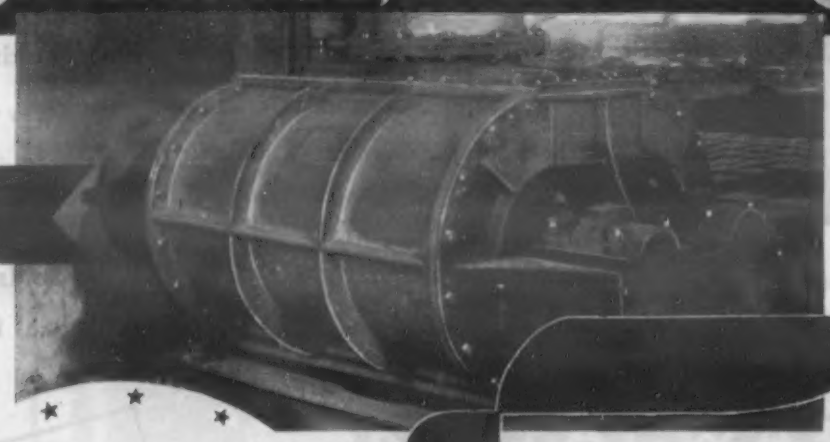

Above photo shows an "R-C" Positive Pressure Blower delivering air blast of 7,200 c.f.m. at 308 r.p.m.

A complete range of sizes with capacities up to 50,000 c.f.m.

Write for Bulletin

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405 Superior Ave. Connersville, Ind.

Roots CONNERSVILLE SINCE 1854 Rotary Positive BLOWERS

president, Draper Mfg. Co., Cleveland; John Hauerwaas, president, U. S. Steel Products Co., New York; E. C. Gardner, vice president, National Enameling and Stamping Co., Granite City, Ill.

A new educational sound motion picture, "Magnesium Metal from the Sea," has been released by the Bureau of Mines. It is a 16-mm. film, 23 min. long. No charge is made for showing it. The Bureau of Mines should be addressed at Experiment Station, 4800 Forbes St., Pittsburgh 13, Pa.

Purdue University, Lafayette, Ind. has established a new joint industry education enterprise for the "intensive training of graduate students in exploring the field of heat transfer for data upon which many of the practical developments of the future depend." It was made possible by a $75,000 grant from Westinghouse, and the five-year program will be directed by Dr. George A. Hawkins of the Purdue faculty.

The Engineering Society of Cincinnati announces the dedication of a building to house a library for the use of engineers of the community. Industrial interests are supporting the project, which is a memorial to the late Herman Schneider, dean, Engineering School, University of Cincinnati.

Meetings and Expositions

SOCIETY OF THE PLASTICS INDUSTRY, annual meeting. Chicago, Ill. May 11-12, 1944.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, semi-annual meeting. Cleveland, Ohio. May 14-16, 1944.

NATIONAL METAL TRADES ASSOCIATION, annual meeting. New York, N. Y. May 17-18, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, Diesel, fuels and lubricants meeting. Chicago, Ill. May 17-18, 1944.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, spring meeting. Boston, Mass. May 18-20, 1944.

AMERICAN GEAR MANUFACTURING ASSOCIATION, spring meeting. Rye, N. Y. May 22-24, 1944.

AMERICAN IRON AND STEEL INSTITUTE, general meeting. New York, N. Y. May 25, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, war materiel meeting. Detroit, Mich. June 5-7, 1944.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Pittsburgh, Pa. June 19-22, 1944.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. New York, N. Y. June 26-30, 1944.

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By Edwin F. Cone

Consumption and Supplies of Scrap

In the 28 months (2⅓ yr.) since Pearl Harbor, the American iron and steel industry has produced 185,000,000 tons of steel ingots and about 35,000,000 tons of castings, consuming approximately 130,000,000 tons of scrap and 120,000,000 tons of pig iron, according to E. C. Barringer, president and executive secretary of the Institute of Scrap Iron and Steel in an address. In 2⅓ yr. of war the iron and steel and allied industries have equaled 3½ yr. of the best peacetime rate of output, a record matched by no other group of basic industries. So long as the war emergency lasts there will be need for every ton of carbon free scrap that can be produced and a substantial volume of other grades. Decimation in the ranks of collectors will be strongly felt and complacency as to supplies should be abandoned.

Re-rolling Used Steel Rails

The output of re-rolled rail steel has been on the increase. As a result of a carefully planned program of the WPB, which was begun early in 1943, the increase has been more than 80%, according to a statement by John T. Whiting, director of the steel division of WPB. There are 22 rail steel mills in the United States which produce steel bars and small shapes by re-rolling used rails. Large companies operate 5 of these and the small firms the remainder. Many of these were on the verge of closing down in late 1942.

Silver Consumption

Silver going into industrial consumption is on the increase. For 1943 the total was 125,000,000 oz., an increase of 10,000,000 oz. over the 1942 total. Part of this increase is due to the expanding use of silver in bus bars and in solders in place of other metals, copper and tin in particular.

Post-War Axis Light Metals

As soon as the occupation of Germany and Japan is complete, a careful industrial survey should be made of the requirements of self-sufficient civilian economy, says P. D. Wilson in an article in *Mining and Metallurgy* for April. Any aluminum capacity in excess of that determined as necessary should then be scrapped. To shut down all magnesium reduction plants in the Axis countries immediately on cessation of hostilities would be entirely feasible. Germany's pre-war need for aluminum was about 50,000 tons a year — her war production is from 300,000 to 400,000 tons each year. Japan could be amply supplied in peacetime with 20,000 tons of aluminum a year; her 1943 output was about 150,000 tons.

"Secret Offensive Weapon"

According to one authority we have gradually developed a "secret offensive weapon" and metals have played an important role in this trend. The greatest single defensive weapon in the hands of the U. S. in this war has been the feverish search of the American oil man to find new uses for oil and its many by-products, said John M. Lovejoy, president of the Seaboard Oil Co. of Delaware, in a recently published interview. "It might with even greater exactness be called 'our secret offensive weapon,' for without that feverish search for new uses and new products, we might not have had the 100-octane gas to power our long range fighters and bombers, nor the toluene to make explosives, nor the butadiene to supply us with rubber substitutes, nor the new medicines to heal disease and wounds."

Automobile Scrap

While only 1,000,000 automobiles were sent to the scrap pile in 1942, there were at least 1,500,000 cars to be disposed of in 1943, says the Office of Defense Transportation. That is getting nearer to the bottom of the pile. The shortage of cars has been one reason for setting ahead the serviceable life of a car to 60,000 miles by the O.D.T. — not inducive to the increase of the scrap supply.

Tantalum from Brazil

Fairly substantial quantities of tantalite ore — source of the metal tantalum, much needed in the war effort — are coming out of the interior mines of Brazil. An estimated 3000 tons of rock must be mined to get 1 ton of tantalite, and it takes one man 130 days to crush, wash and prepare a ton of ore for shipment.

Ton-Miles of Freight

The volume of freight handled by American railroads has expanded to a surprising volume. In 1943 it amounted to about 725,447,456,000 revenue ton-miles according to preliminary estimates by the Association of American Railroads. This total is an increase of 13.7% over 1942, an increase of 53% over 1941 and one of 118% over that of 1939. A large proportion of this freight volume was metal products.

Domestic Fluorspar

Production and shipments of fluorspar last year were adequate to cover domestic consumption which amounted to 386,000 tons, an increase of 7% over 1942, the former record year.